

Muzeul Județean Mureș

MARISIA



Studii și materiale

XXXV

Științele Naturii

2015

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XXXV

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CONSILIUL
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CP 85, str. Mărăști nr. 8A, 540328

Târgu-Mureș, România

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Front cover: *Narcissus poeticus* L. ssp. *radiiflorus* (Salisb.) Baker (photo and design: Mihaela Sămărghițan)

ISSN: 1016–9652

EDITURA MEGA | www.edituramega.ro

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MUZEUL JUDEȚEAN MUREȘ

MARISIA

STUDII ȘI MATERIALE

XXXV

ȘTIINȚELE NATURII

Târgu-Mureș
2015

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Marisia XXXIII–XXXIV, 2014 (Științele Naturii)
Marisia XXXIV–XXXV, 2015 (Istorie)

CONTENTS

BOTANY

Mariana LOZINSCHII, Nina CIORCHINĂ, Tatiana CALALB

Micropropagation of blackberry cultivars – perspectives for Republic of Moldova •
Micropropagarea in vitro a unor cultivare de mur - perspective pentru Republica Moldova.....9

Mihaela SĂMĂRGHIȚAN, Silvia OROIAN

The floristic diversity of “Câmpia Transilvaniei” (Mureș County) • Diversitatea floristică a
Câmpiei Transilvaniei (județul Mureș).....17

Sorina Ștefania MATACĂ

The lilac forest from Ponoarele. Phytosociologic considerations • Pădurea de liliac de la
Ponoarele. Considerații fitosociologice.....27

Alina ROVINĂ, Monica NEBLEA

Considerations concerning threatened cormoflora from Grădiștea Muncelului-Cioclovina
Natural Park • Considerații privind cormoflora periclitată a Parcului Natural Grădiștea
Muncelului Cioclovina.....35

**Luminița ROMAN, Anamaria HOSU, Cristiana VASILIU, Horațiu ROMAN,
Gheorghe CIUCĂ, Grigore MIHĂESCU**

Antibacterial activity of compounds derived from hidroethanolic extracts of *Juglans nigra* •
Activitatea antibacteriană a compușilor derivați din extractul hidroetanolic din *Juglans nigra*41

Alina ROVINĂ, Liviu ROVINĂ

Considerations regarding the conservation status of 40A0* subcontinental peri-pannonic scrub
in Grădiștea Muncelului Cioclovina Natural Park • Considerații asupra stării de conservare a
habitatului 40A0* tufărișuri peri-panonice, în Parcul Natural Grădiștea Muncelului Cioclovina...49

Andreea Natalia MATEI

Ligularia sibirica (L.) Cass. chorology in Romania and Europe, along with worldwide chorology
of genus *Ligularia* • Studiul corologic al speciei *Ligularia sibirica* (L.) Cass. în Romania și în
Europa, respectiv corologia genului *Ligularia* la nivel mondial.....57

ZOOLOGY

**Simona NEAGU, Roxana COJOC, Mădălin ENACHE, Ioana GOMOIU,
George GHEMES, Andreea GHEORGHE, Mădălina TUDORACHE**

The growth of halophilic microorganisms in the presence of waste glycerol and its conversion in
glycidol and glycerol carbonate • Creșterea microorganismelor halofile în prezența glicerolului
rezidual și conversia acestuia la glicidol și carbonat de glicerol.....67

NISTREANU Victoria, ANDREEV Sergiu, LARION Alina, POSTOLACHI Vlad, CALDARI Vlad	
Bat species (Mammalia, Chiroptera) hibernating in abandoned stone quarries from Saharna, Republic of Moldova • Speciile de lilieci (Mammalia, Chiroptera) care hibernează în carierele abandonate de la Saharna, Republica Moldova.....	75
Galina BUȘMACHIU	
Survey of Collembola (Hexapoda) of the Codrii Reserve • Studiul colembulelor (Hexapoda) din Rezervația Codrii.....	81
Natalia MUNTEANU MOLOTIEVSKIY, Svetlana BACAL', Oxana MUNJIU, Anna MOLDOVAN	
Aquatic beetles fauna (Coleoptera: Gyrinidae, Haliplidae, Noteridae, Dytiscidae and Hydrophilidae) from the Republic of Moldova • Fauna coleopterelor acvatice (Coleoptera: Gyrinidae, Haliplidae, Noteridae, Dytiscidae și Hydrophilidae) din Republica Moldova.....	95
Liviu ROVINĂ, Alina ROVINĂ	
Aspects regarding fauna from Grădiștea Muncelului Cioclovina Natural Park • Aspecte privind fauna din Parcul Natural Grădiștea Muncelului Cioclovina.....	107
Petru-Vasile ISTRATE, Roxana COSMA	
The message beyond the forms and colours of the tropical butterflies. A study of tropical butterflies from the collection of the National College "Alexandru Papiu Ilarian" from Tîrgu Mureș • Mesajul formelor și culorilor fluturilor tropicali - un studiu al fluturilor din colecția Colegiului Național „Alexandru Papiu Ilarian” din Tîrgu Mureș.....	117
Natalia SOCHIRCĂ, Larisa BOGDEA, Ludmila BUCICEANU	
Preserving and protecting condition of birds species identified in Chișinău • Situația conservării și protejării speciilor de păsări identificate în municipiul Chișinău.....	133

PALEONTOLOGY

Florina DIACONU	
The badenian marine fauna from Neagonea Valley (Mehedinți County) • Fauna marină badeniană de pe Valea Neagonea (județul Mehedinți).....	143

BOTANY

MICROPROPAGATION OF BLACKBERRY CULTIVARS – PERSPECTIVES FOR REPUBLIC OF MOLDOVA

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Abstract: The given paper describes the development of cultivation conditions of some blackberry thornless cultivars of *Rubus lacinatus*, *R. canadensis*, *R. fruticosus* species *in vitro* culture such as: *Thornless evergreen*, *Arapaho*, *Polar*, *Remontana*, *Thornfree*, *Smotherstem*, *Loch Ness*. The sterilization protocol of the original material was assessed. The basal media *Murashige & Scoog 1962 (MS)* with the addition of 30 g/l sugar was created for the *in vitro* initiation and development. The best medium for multiplication is MS 100%, supplemented with a growth regulator, 6-benzylaminopurine (BAP) 0.5 mg/l. And other growth regulators were utilized in the micropropagation process like: Indolylbutyric Acid (IBA), and Acid Naphthyl Acetic (NAA).

Keywords: cultivar, *in vitro*, initiation, blackberry, micropropagation, culture medium, growth regulator.

Introduction

Plant biotechnology is one of the main achievements of the twentieth century, with a particular role in developing modern agriculture and horticulture. *In vitro* micropropagation is a branch of plant biotechnology which represents a collection of plant multiplication methods using *in vitro* cell cultures, plant tissues and plant organs. The use of this technique permits to considerably increase the efficiency of multiplication of different species, and it is also a method to free the pathogens from the seedling material.

Micropropagation of shrubs was investigated by many researchers who explored the initiation, multiplication and acclimation of a new variety of thornless blackberry ‘Cacanska bestrna’ [3, 6]. At the Botanical Garden (Institute) of Academy of Science of Moldova (ASM), the micropropagation and multiplication of blackberry cultivars was started in 2010 and there were obtained good results in the initiation, multiplication, rootedness, *ex vitro* adaptation of some cultivars [4, 5]. At Fruit Research Station of Cluj, an effective method was obtained, which combines two phases, a direct *ex vitro* rooting and acclimation of blackberry shoots in the hydroculture flotation [2]. Based on hydroponic flotation technology and *ex vitro* acclimation of *Loch Ness* blackberry [1].

The present work reveals some problems regarding the multiplication of valuable varieties of blackberry using biotechnology methods. The aim of the research brought up in this paper

was to test different culture media, which are effective in the *in vitro* stage and are appropriate to obtain a uniform and vigorous, free of diseases planting material.

Materials and methods

The research took place in the Biotechnology and Embryology Laboratory of Botanical Garden (I) of the Academy of Sciences of Moldova. There were studied and researched valuable varieties of thornless blackberry. Plantlets were propagated *in vitro* according to a standard protocol, investigated in the laboratory [4, 5].

In order to highlight the biological and technical characteristics to be compared in scientific investigations, several new blackberry cultivation species were used *Thornless evergreen*, *Arapaho*, *Remontana*, *Thornfree*, *Smoothstem* of American origin, *Pola* -Polish origin, *Loch Ness* – Scottish origin, that come from, *R. fruticosus*, *R. lacinatus*, *R. canadensis*, family Rosaceae, which were *in vitro* multiplied blackberry plantlets were propagated *in vitro* according to a standard protocol, investigated in the Laboratory of Biotechnology of the Botanical Garden (Institute) of the Academy of Science of Moldova.

Researchers are trying to obtain new blackberry varieties and forms with outstanding features: resistance to frost and to phytopathogenic influence, fruit with different ripening terms, longer retention, new taste qualities and resistance to mechanical actions. These new varieties of blackberry would provide consumers with fresh fruit rich in various vitamins and other constituents – biologically active substances (BAS) of an excellent therapeutic and alimentary value for a longer period.

Cultivars are characterized by different ripening periods of fruits *Arapaho*, *Loch Ness* (*R. fruticosus*) – the early ones, *Thornless evergreen* (*R. lacinatus*), *Chester*, *Thornfree*, *Polar* (*R. fruticosus*) – late ones (July-September). The *Reuben* cultivar has the ability to fructify from June to October. The mentioned cultivars are different if looking at their biological characteristics of the plant: repent strains – *Evergreen*, *Loch Ness*, *Thornfree*, *Smoothstem*, tipped – *Chester*, *Reuben* and erect – *Arapaho*, *Polar*; a medium degree of vigor goes to *Chester* and *Arapaho* cultivars whilst vigorous cultivars are considered *Evergreen*, *Thornfree*, *Polar*; All cultivars are resistant to the climatic conditions specific to Moldova.

Microcloning and *in vitro* micropropagation techniques were used in order to obtain homegenous vegetative material at the Laboratory of Biotechnology and Embryology of the Botanical Garden (Institute) of ASM.

Results and discussions

In order to initiate the *in vitro* culture, axillary and lateral buds were used, which were removed through the elimination of the internode and which were washed in running tap water. Apical, axillary buds, that come from annual semilignificate growings (April to September) ensure the success of the initiation phase of the investigated cultivars. Before inserting the plant material, that was harvested from the donor plant, it was essential to sterilize it. First, the plant material was well-washed under running water for two hours. Then, the sterilization was carried out in a bay, where the 0.1% diacid was used as a sterilizing agent, preceded by a prior disinfection with KMnO_4 . The optimal treatment with mercuric chloride 7 minutes, then the material was rinsed 3 times with 0.5% H_2O_2 concentration, deionized autoclaved water for all types of explants. The apical and axillary buds, earlier disinfected, are modeled under a binocular magnifier while every trace of wood and rind, as well as 2–3 layers of scales are being removed.

The shaped inoculums are inserted in tubes with the nutrient medium of MS 100% agarose gel, approximately 9–10 ml medium/tube. In the initiation phase, 50–85% of explants survived and generated plants. Depending on the cultivar, there were selected only the tubes in which the generated and transferred inoculums survived on nutrient media MS 100% with the addition of BAP 0.5mg/l. It was stated that in the multiplication phase of the thornless blackberry variety, the optimal type of inoculums are portions of shoots or shoots having 0,5-0,7cm in length. Nutrient media was prepared using micro- and macro stock solutions, vitamins. All components were added before autoclaving. The pH of the medium was adjusted to 5.8. The media was distributed in tubes made of glass, 15 ml of medium in each tube, and sterilized by autoclaving at temperature 120° C for 15 minutes.

For the micropropagation of the micropropagula, the liquid medium MS was tested in two experimental variants: 100% and 50%. The first medium is being more often used to obtain increased amounts of plant material. The 50% option is used as a rooting medium, as well as a medium for preservation for a certain period. MS medium was tested with different additions, but the most efficient and effective for morphogenetic initiation of blackberry seedlings is the 100% MS with a 5.8 pH before autoclaving.

Rootedness process initiation was observed within 14 days from the *in vitro* transfer in this nutrient medium, and in 20–30 days a significant plant growth is observed, which can be used as seedling material for a further layer while the lower part of the plant is being transferred to *ex vitro* (Photo 1). For further micro-propagation, we use as segment consisting of one or two internodes, the explant segment must be as vigorous and healthy so we can obtain a qualitative seedling material. The length of the cuttings for micropropagation is 2–2.5 cm. It is very important for the sprig to be vigorous, so the micro-propagation process will be successfully completed. Once the sprig has reached a length of 12–14 cm it is subject to cutting and eventually transferred to other nutritive media for further micro-propagation. Thus, the biological material efficiency increases 4–5 times within 30–40 days. The plants are grown in a room with 16-hour light photoperiodicity and 8 hours of darkness, with an average temperature of $23 \pm 20^{\circ}\text{C}$. (Photo 1).



Photo 1: The cultivation room, micro-propagation of the *Loch Ness* cultivar

In order to keep the plants in liquid, paper filter pads are placed in the test tubes. It was determined that 100% MS medium, with a 5.8 pH before autoclaving, is an efficient and optimal medium for the morphogenetic seedling initiation. A number of different nutrient media

were tested in order to optimize them to start the morphogenesis process. The basic medium for the morphogenetic induction is Murashige-Skoog, with 30 g/l alimentary sugar, 6 g/l agar additions and a 5.6–5.8 pH. For better growth and multiplication a non-agar MS was used, a liquid with added growth regulators. Bobrowski, *et al.* (1996) tested several variants of MS media with 1 and 2 mg/l BAP. Ruzic D. and Lazic carried out experiments (2006) using thornless blackberry, the highest multiplication rate was ensured by the variant of MS medium with 1 mg/l BAP, 0.1 mg/l IBA and 0.1 mg/l GA₃. In our experiments the best results were obtained on MS medium with BAP in the concentrations 0.3, 0.5, 0.7 mg/l. Also, increased amounts of BAP 0.9, 1.0 mg/l were tested, but they cause aberrations of the shoot, the best quantity proved to be 0.5 mg. When placing the culture medium with added BAP, the side shoots induction considerably extends on the plant axis, which favors a multiple plant sprouting. Eventually, this serves as biological material for micro-propagation and the increase of vegetative mass (Photo 2).

As we increase the BAP concentration, we get a larger number of adventitious shoots which reach 4–6 cm in length and which go through a further micro-propagation preserving their morphogenetic potential. All types of plants have been micro-propagated on the nutrient media with BAP addition. Efficient results were obtained for all blackberry cultivars, only the number of shoots and their vigour made a slight difference. The more the number of explants per tube, less vigor of the explant is obtained, therefore the BAP versions of 0.3, 0.5, 0.7 mg/l, were chosen for research.

When a lower concentration of cytokinins, the BAP (0.3 mg/l), is used, the number of shoots is less than 14 for the *Chester* blackberry type, and 16 for *Loch Ness*, but the shoot may reach 10 cm in length, in 55–60 days for both cultivars. A good result is often obtained when the BAP is 0.5 mg/l, and 25 adventitious shoots appear in the same period of time (in average for both cultivars). The best result was on the nutrient media with a 0.7 mg/l added BAP, when 30 adventitious shoots have developed for the *Chester* type, and 34 adventitious shoots for *Loch Ness* in 55–60 days, but reaching only 5–7 cm in length.

For the *Thornless evergreen* cultivar, the most effective multiplication media is MS with BAP (0.5 mg/l) addition. In 50–55 days, on this medium, a total of 19–20 adventitious shoots are obtained, that reach 7 cm in length (tab. 1).

While investigating the multiplication of *Smoothstem* and *Reuben* cultivars, it was noted that an effective result was obtained on MS medium with BAP (0.5 mg/l) addition. The duration of multiplication on this medium is 55–60 days, with an amount of 23 adventitious shoots that reach 4 to 5 cm in length (Table 1). For *Arapaho*, *Thornfree* and *Polar* cultivars, 24–26 adventitious shoots per tube were observed, considering the fact that the mini sprout had a much more increased vigor (Table 1).

Table 1: Multiplication of blackberry on medium with BAP

Cultivar growth regulator	Medium %	Concentration (mg/l)	Growth time (days)	Shoots' number	Shoots' length (cm)
Chester	MS 100	0.3	55–60	13±0.19	10.2±1.87
		0.5		22±0.24	7.9±1.37
		0.7		30±0.16	6.9±1.37
Loch Ness	MS 100	0.3	55–60	16 ±0.15	9.7±1.49
		0.5		29±0.17	6.3±0.94
		0.7		34±0.14	4.8±1.31
Thornless evergreen	MS 100	0.3	55–60	12±0.20	8.0±1.05
		0.5		19±0.13	6.9±1.19
		0.7		24±0.12	4.9±1.37

Cultivar growth regulator	Medium %	Concentration (mg/l)	Growth time (days)	Shoots' number	Shoots' length (cm)
Smotherstem	MS 100	0.3	55–60	14±1.17	9.1±1.19
		0.5		23±0.10	4.9±0.87
		0.7		26±0.09	3.9±1.10
Reuben	MS 100	0.3	55–60	12±0.2	4.7±1.41
		0.5		20±0.09	4.2±0.91
		0.7		24±0.20	2.7±1.05
Polar	MS 100	0.3	55–60	15±0.16	8.0±0.15
		0.5		24±0.20	6.5±0.25
		0.7		29±0.17	4.5±0.37
Arapaho	MS 100	0.3	55–60	13±0.19	7.5±0.19
		0.5		20±0.19	6.1±0.08
		0.7		26±0.09	3.5±0.08
Thornfree	MS 100	0.3	55–60	12±0.11	8.9±0.19
		0.5		18±0.13	6.7±0.08
		0.7		25±0.09	4.2±0.15

According to table 1: data analysis, it is observed that as we increase the concentration of cytokinins, the shoot length decreases, and when the BAP concentration decreases, the shoot length increases. At a concentration of 0.7 mg/l BAP, the maximum reached length is 6.9 cm, and at a concentration of 0.3 mg/l, the shoot reaches 10 cm in length.

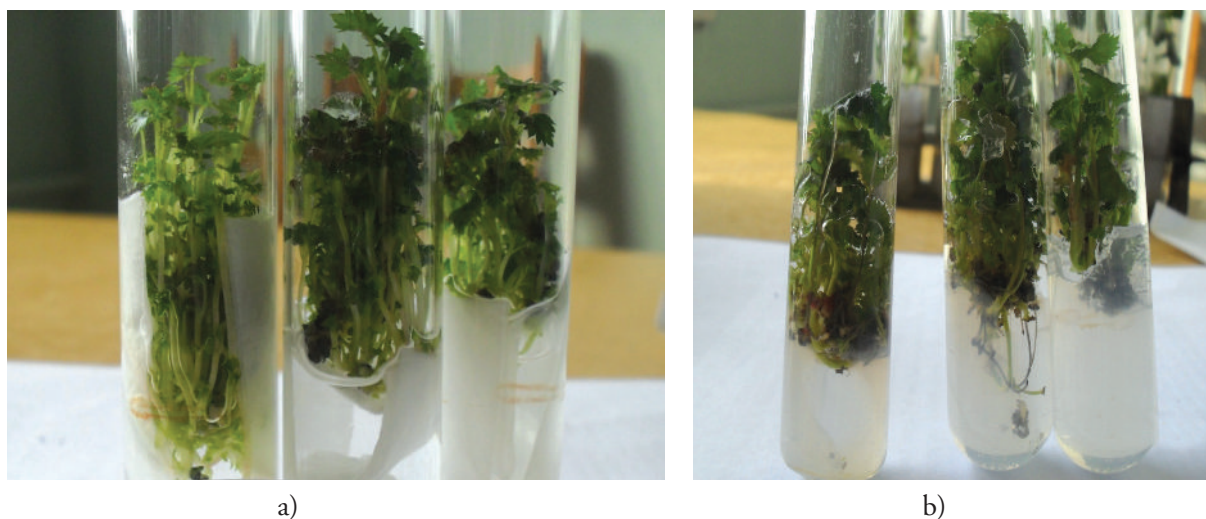


Photo 2: *Chester* (a) and *Loch Ness* (b) multiplication

This shows what affects the developing of adventitious buds (Photo 2), the need to increase the BAP concentration that considerably increases the number of shoots.

Also, it was being researched the MS medium supplemented with auxine. *Chester*, *Loch Ness* and *Thornless Evergreen* cultivars were used to analyze the MS medium with addition of (IBA). In the research we used 2 different nutrient media with IBA additions, in concentrations of 0.1 mg/l and 0.2 mg/l. Minimal concentrations of the growth regulator were used not to facilitate the plant's inhibition. After a period of 21 days, a thickened formation was observed at the shoot base in both cases, for *Chester* and *Loch Ness* cultivars. The *Loch Ness* shoot reached 6 cm in length, while the *Chester* shoot reached 7 cm in length, on the nutrient media with IBA concentration of 0.2 mg/l, but on the IBA concentration of 0.1 mg/l, the *Loch Ness* shoot reached 5 cm in length and *Chester* reached 6 cm.

In 35–40 days, on both media, both cultivars developed a white callus formation at the base of the plant, while the root system was less developed. On average, on IBA (0.1 mg/l) medium, *Loch Ness* reaches 7–8 cm in length and *Chester* reaches 8–9 cm. When the IBA addition is 0.2mg/l, the shoots reach different lengths, of 8–10 cm for the *Loch Ness* cultivar and 10–12 cm for the *Chester* one.

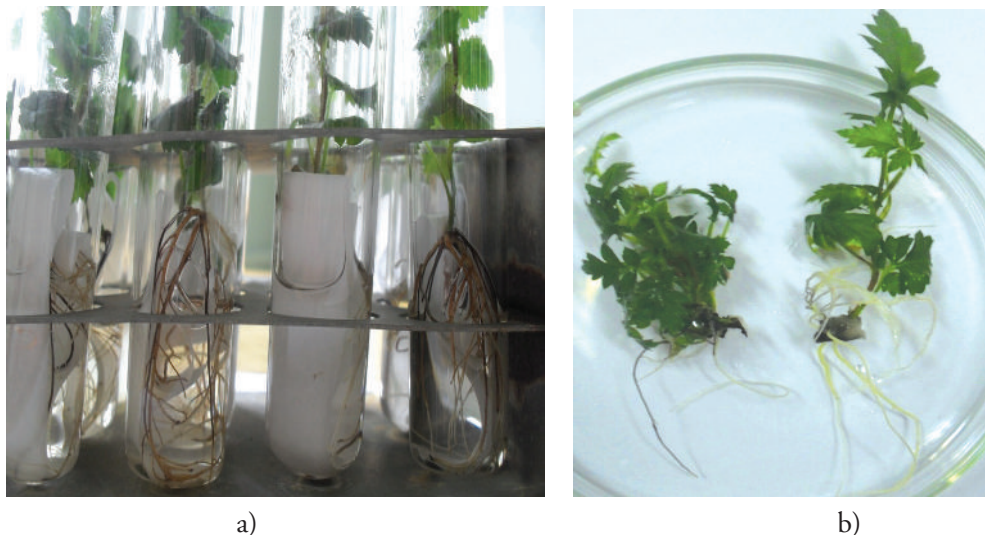


Photo 3: a) *Smoothstem*; b) *Thornless evergreen* Rooted on the medium replenished with NAA

A positive influence on *Thornless evergreen* cultivar showed the medium filled with auxine. On the medium supplemented with IBA, the roots are developed as well as a white callus formation, while on the medium supplemented with NAA, the root system develops entirely as well as the plant. To optimize the micropropagation of this cultivar, we used the 50% MS medium with the addition of 30 g sugar, a liquid supplemented with NAA in concentration of 0.1, 0.2 mg l, on this medium, the sprout grows vigorously up to 12 cm in 30 days and it is rooted in 14 days. The first roots appear in 10–12 days on this medium, during this period the shoot length is 5 cm. In contrast to *Chester* and *Loch Ness*, the rootedness here is well-developed (Photo 2). For the *Reuben* and in particular, for *Smoothstem* cultivars, an optimum and efficient medium has been established, both for proper growth, and rootedness, with 50% MS composition and 0.1mg/l NAA. On this substrate, the plant axis grew to 8 cm in 30 days, and it was observed that the basal part of the plant had a branched root system, made of 5–6 brached white roots (Photo 3). The plant with it's increased vigor, has a growth high potential, eventually, its cuttings are further micro-propagated on culture media, while the basal part of the shoot is passed to *ex vitro*.



Photo 4: Cultivar *Polar* on culture medium MS 50%

All varieties of plants have been micropropagated on the basic medium MS 100% with the addition of growth regulators BAP, IBA, NAA (tab.2). In order to make the *Polar*, *Arapaho*, *Thornfree* cultivar root, nutritive media MS 50% liquid with the addition of 30g/l sugar and 15/l sugar was used (Photo 4). The optimal medium for rootedness process is the 50% MS medium, liquid, added with 30g of sugar, root emergence was observed in the first 10 days after transfer on this medium. In 21 days the plant is well rooted and reaches 4 cm in length, the root system has 5–6 roots with 2– 2.5 cm in length (Photo 5).



Photo 5: Rootedness process development MS 50% medium for Arapaho

The apical part of the plant is transferred to the culture medium to further induce morphogenetic development in the *in vitro* culture, while the basal part of 2–3 internodes is being transferred to *ex vitro* to be naturalized and it develops subsequently to achieve the vegetative and generative phases.

Rootedness occurs simultaneously at all cultivars, but the roots vary. It was observed that *Chester* and *Loch Ness* develop 5–7 unbranched long shoots, with 0.8 mm diameter. *Smoothstem* and *Reuben* shoots are rough and have 1mm diameter. *Evergreen* has 6–7 shoots and 0,8– 0,9 mm diameter (Photo 3).

Thus, we have established that the optimal, cost-effective and appropriate medium for blackberry varieties' rootedness is MS 50% (Photo 5).

Conclusions

1. *Chester*, *Loch Ness*, *Thornless evergreen*, *Smoothstem*, *Remontana*, *Polar*, *Arapaho*, *Thornfree* varieties can be successfully approved in Moldova, and can be used as a donor for plant micropropagation.
2. The elaboration of the sterilization protocol of the plant material taken from the donor-plant is an essential contribution to the initiation stage of *in vitro* culture.
3. It was elaborated a technology to obtain seedling material for qualitative and homogeneous blackberry cultivars through in vitro cultures, the stages of initiating, microcloning and

rootedness are described. The most appropriate and optimal substrate for the growth of plants is MS100% and 50% for maintenance and rootedness.

4. The growth and rootedness processes were initiated on a more economic medium, MS 50% where the rootedness is formed in 20 days, and the shoot growth is vigorous and successfully participates in the micropropagation process.

5. Supplemented BAP in the basic medium that has selective action played an important role in the initiation of morphogenesis. Rootedness was stimulate by filling the nutrient medium with IBA and NAA, so the rooting became visible after 10–12 days after cultivation.

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MICROPROPAGAREA *IN VITRO* A UNOR CULTIVARE DE MUR – PERSPECTIVE PENTRU REPUBLICA MOLDOVA (Rezumat)

În lucrarea dată se descriu condițiile de dezvoltare a unor cultivare de mur fără spini *Thornless evergreen*, *Cester*, *Arapaho*, *Polar*, *Remontana*, *Thornfree*, *Smoothstem*, *Loch Ness* a speciilor *Rubus laciniatus*, *Rubus canadensis*, *Rubus fruticosus*, în cultura *in vitro*. A fost stabilit protocolul de sterilizare a materialului inițial. Pentru inițiere și dezvoltare *in vitro* a fost selectat mediul de bază Murashige & Scoog 1962 (MS), cu adaos de 30 g/l zahăr. Mediul optim pentru microclonare este MS 100%, adăugat cu regulator de creștere, 6-benzylaminopurine (BAP) 0.5 mg/l. Rizogeneza mai eficientă s-a obținut pe mediul MS 50%, cu adaos de 30 g/l zahăr.

THE FLORISTIC DIVERSITY OF “CÂMPIA TRANSILVANIEI” (MUREȘ COUNTY)

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Abstract: The objective of this study is to analyze the floristic diversity of Câmpia Transilvaniei in Mureș County. The “Câmpia Transilvaniei” is characterized by a high diversity of vegetal taxa; the checklist of flora in this area reveals a count of 716 vascular taxa, meaning 692 species, 24 subspecies and 2 forms, belonging to 96 plant families.

The paper analyzes the floristical diversity of the studied area taking into consideration the presence of some micro arealophyte species, endemic species, Balkanic and Mediterranean species which gives specificity to the flora of “Câmpia Transilvaniei”. The presence of some rare, threatened, vulnerable plants of communitarian interest that are listed in National Red Lists is also revealed in the report.

Alien plants, an important group of plants identified in the field are present. Cataloging these alien plants is important to understand the spread of these populations and how their growth detrimentally impacts the indigenous species.

Keywords: floristic diversity, rare, threatened, vulnerable, endemic species, Câmpia Transilvaniei

Introduction

The impact on the taxonomic diversity of biospheres reveals breadths and intensities that could not have been suspected a few decades ago. One of the biggest tasks of contemporaneity is the conservation of flora and fauna of the planet impacting a greater number of species, regardless of their biological importance. Accordingly, the main focus of nature conservation has become an endeavor to protect taxonomic diversity of populational components of natural and semi-natural ecosystems with their genetic structure [3].

The Transylvanian Plain is located in the the central part of the Transylvanian Basin. It has approximately 5,000 square kilometers and spreads across parts of three counties: Bistrița Năsăud, Mureș and Cluj.

In Mureș county, the Transylvanian Plain, north of the River Mureș (Fig. 1) is a lowland region consisting of gently rolling hills (average elevation – 400 m), with wide valleys formed by the tributaries of the river Mureș crossing among the hills. The part of the Transylvanian Plain situated in the Mureș County is called the Mureș Plain and includes the Hilly Plain Sărmaș (situated almost entirely in the Transylvanian Plain domes) and Mădăraș Hills (located in the eastern section of the Mureș Plain next to the Reghin Hills).



Fig. 1: Câmpia Transilvaniei (Mureș County) [13]

Contrary to its name, the Transylvanian Plain is not geographically a plateau, but rather a collection of hills. Uniform altitudinal landforms, low landform energy, landslides, valleys with radial-excentric character, ponds, and short rivers without terraces, are many features of the Transylvanian Plain. Agricultural land occupies about 90% of the total area and forests only 9% with significant differences from one place to another.

The studied area overlaps the area of gas domes and the Tortonian-Sarmatian formations composed of marl, clay, sand, volcanic tuffs and conglomerates on the edges.

The climate of Transylvanian Plain shows differences between north and south, as well as a number of topoclimates specific to broad valleys areas. The average annual temperature is 8–9 °C and the rainfalls, generally deficient, reach 500–600 mm/year.

Material and methods

The floristical diversity of the studied area was analyzed taking into consideration the presence of some micro arealophyte species, endemic species, Balcanic and Mediterranean species which gives specificity to the flora of “Câmpia Transilvaniei”.

The names of the species are in accordance with *Flora Europaea* [15, 16] and Sârbu, I., Ștefan, N., Oprea, A. [14] and the floristical elements are established by Sârbu, I., Ștefan, N., Oprea, A. [14].

To identify the threatened, vulnerable and rare species we took into consideration the National Red Lists [3, 5, 7, 9, 10], The Carpathian List of Endangered species [17] and the latest version of sozological categories published in the *IUCN Red List Categories* booklet (1994) [8].

The zoological categories for each species are according to IUCN and the red lists used.

An increasing major threat to indigenous biodiversity in Europe and worldwide is invasive species. Because of the negative impact invasive species have on habitats and native species it is important to identify them. To accomplish this, systematic monitoring researches of the populations in their habitats is required. The invasive species recorded in the studied area were established by Anastasiu, P. & Negrean, G. [1, 2] and Dihoru, G. [6].

Results and discussions

As a consequence of the regional localization, of the diversity of relief (hills, meadows) and of the diverse expositions and inclination of slopes, The Transsylvanian Plain is characterized by a diversity and richness of vegetal taxa: 716 taxa including 692 species, 24 subspecies and 2 forms belonging to 96 plant families. The number of species in the Transylvanian Plain determined so far is 20.45% of all known species of our country (3500 species after Flora R.P.R. and R.S.R.). This significant percentage allows us to appreciate that the studied area is a region with a rich and varied flora. [13]

Out of this flora a remarkable phytogeographical interest has some micro arealophyte species, endemic and subendemic species. Thus, between endemic species we mention *Aconitum lycoctonum* L. em. Koelle ssp. *moldavicum* (Hacq.) Jalas (End. Carp.), *Pulsatilla pratensis* (L.) Mill. ssp. *flavescens* (Hazsl.) Holub (P. *pratensis* (L.) Mill. ssp. *hungarica* Soó) (Pan-End), *Pulsatilla vulgaris* Mill. ssp. *grandis* (Wender.) Zämel (Eur (centr.)-End), *Cephalaria radiata* Griseb. et Schenk (End), *Salvia transsylvanica* (Schur ex Griseb.) Schur (End), *Jurinea mollis* (L.) Reichenb. ssp. *transsylvanica* (Spreng.) Nyman (subEnd.), *Delphinium simonkaianum* Pawl. (End).

The presence of the Daco-Balkan and Ponto-Balkan floristic elements give a particular aspect of this area, demonstrating the intensity of their differentiation and conservation of tertiary and Pleistocene flora. The presence of some phyto-historical interference in the distant past with the Balkan peninsula and Anatolia is attested by Balkan species. Out of the Balkanic elements in study area we mention: *Melampyrum bihariense* A. Kern.(Dac), *Allium denudatum* F. Delaroche (*Allium albidum* Fischer ex Bieb. ssp. *albidum*, *Allium flavescens* Besser, *Allium ammophilum* Heuffel) (Pont-Dac-Balc), *Linum flavum* L (Pont-Pan-Balc), *Euphorbia epithymoides* L. (*Euphorbia polychroma* A. Kern.) (Eur-Balc), *Trinia ramosissima* (Fisch. ex Trevir.) W. D. J. Koch (Pont-Pan-Balc), *Cephalaria uralensis* (Murray) Roem. et Schult (Pont-Balc), *Ajuga laxmannii* (Murray) Benth. (Pont-Pan-Balc), *Rhinanthus rumelicus* Velen. (Pont-Pan-Balc), *Scrophularia scopoli* Hoppe (Pont-Pan-Balc), *Veronica orchidea* Crantz (Pont-Pan-Balc), *Asyneuma canescens* (W. et K.) Griseb. et Schenk (Pont-Pan-Balc), *Carduus hamulosus* Ehrh. (Pont-Pan-Balc), *Centaurea stoebe* L. ssp. *australis* (A. Kern) Greuter (*Centaurea biebersteinii* DC. ssp. *biebersteinii*) (Pont-Pan-Balc), *Inula ensifolia* L. (Pont-Pan-Balc), *Serratula radiata* (Waldst. et Kit.) Bieb. (Pont-Pan-Balc), *Allium paniculatum* L. (Pont-Pan-Balc), *Iris pumila* L. (Pont-Pan-Balc), *Iris variegata* L. (Pont-Centr-Eur-Balc), *Muscari tenuiflorum* Tausch. (Pont-Pan-Balc), *Polygonatum hirtum* (Bosc ex Poir.) Pursh (*Polygonatum latifolium* (Jacq.) Desf.) (Pont-Pan-Balc), *Helleborus purpurascens* W. et K. (Carp-Balc-Pan), *Corydalis solida* (L.) Clairv. ssp. *slivenensis* (Velen.) Hayek (Balc), *Goniolimon tataricum* (L.) Boiss. (Pont-Pan-Balc), *Cytisus albus* (Hacq.) Rothm. (Pont-Pan-Balc), *Cytisus hirsutus* L. ssp. *leucotrichus* (Schur) A. Löve&D. Löve (*Cytisus leucotrichus* Schur) (Balc-Pan), *Lathyrus palleescens* (M. Bieb.) K. Koch (Pont-Pan-Balc), *Lathyrus pannonicus* (Jacq.) Garke (Eur (centr.&NV)-Balc).

The high number of Balkanic and Mediterranean species prove the steppic character of this area.

Despite the relatively low altitude of the territory, they met some Alps-Carpathian species as *Allium ericetorum* Thore (*Allium ochroleucum* Waldst. et Kit.) (Alp-Carp).

Due to historical conditioning of post-glacial period, in this territory is remarkable the presence of a significant contingent of Mediterranean species. Mediterranean elements are present in species such as: *Aristolochia clematitis* L. (Med), *Nigella arvensis* L. (Pont-Med), *Silene italica* (L.) Pers. (Med), *Prunus avium* L. (*Cerasus avium* (L.) Moench) (subMed), *Prunus mahaleb* L. (*Cerasus mahaleb* (L.) Miller) (subMed), *Rosa gallica* L. (Pont-Med), *Astragalus monspensulanus* L. (Pont-Med), *Trifolium michranthum* Viv. (Atl-Med), *Trifolium pannonicum* Jacq. (Pont-Med), *Cotinus coggygria* Scop (Pont-Med), *Polygala major* Jacq. (Pont-Med), *Rhamnus saxatilis* Jacq. ssp. *tinctorius* (Waldst. et Kit.) Nyman (centr. Eur-Med), *Cornus mas* L. (Pont-Med), *Hedera helix* L. (Atl-Med), *Anthriscus cerefolium* (L.) Hoffm. ssp. *trichosperma* (Schult.) Arcang. (Pont-Med), *Bifora radians* Bieb. (Med), *Eryngium campestre* L. (Pont-Med), *Ferulago sylvatica* (Besser) Reichenb. (Pont-Med), *Oenanthe silaifolia* Bieb. (subMed-Med), *Peucedanum ruthenicum* M. Bieb. (E-Med), *Viola odorata* L. (Atl-Med), *Hesperis tristis* L. (Pont-Pan-Med), *Raphanus raphanistrum* L. (Med, Cosm), *Primula vulgaris* Huds. (*Primula acaulis* (L.) L. ssp. *acaulis*) (subMed), *Dipsacus fullonum* L. (subMed), *Anchusa barbelieri* (All.) Vitm. (Pont-Med), *Ajuga chamaepitys* (L.) Schreb. (Pont-Med), *Glechoma hirsuta* W. et K. (Pont-Med-Centr.Eur), *Mentha spicata* L. ssp. *spicata* (Atl-Med), *Stachys annua* (L.) L. (E-Med), *Stachys germanica* L. (Pont-Med), *Cartamus lanatus* L. (Pont-Med), *Centaurea cyanus* L. (Med), *Scorzonera hispanica* L. (Pont-Med), *Xeranthemum annuum* L. (Pont-Med), *Asparagus tenuifolius* Lam. (Pont-Med), *Fritillaria montana* Hoppe ex W. D. J. Koch (Pont-Med), *Ornithogalum umbellatum* L. (subMed), *Chrysopogon gryllus* (L.) Trin. (subMed).

In the Transylvania Plain flora there are a number of taxa in various stages of endangerment which are mentioned in national and international red lists. Thus, this territory meet 9 species of Community interest listed in Habitats Directive and OUG 57/2007 such as: *Agrimonia pilosa* Ledeb., *Galanthus nivalis* L., *Echium maculatum* L., *Iris aphylla* L. (*Iris hungarica* Waldst. et Kit.) *Pulsatilla pratensis* (L.) Mill. ssp. *flavescens* (Hazsl.) Holomb (*P. pratensis* (L.) Mill. ssp. *hungarica* Soó), *Agrimonia pilosa* Ledeb. In the studied area can meet also species of national interest like: *Cephalaria radiata* Griseb. et Schenk and *Astragalus exscapus* L. ssp. *transilvanicus* (Barth) Jav.

A number of species included in national red lists were identified in the Transylvanian Plain cormoflora. (Table 1)

From the red list of extincted, threatened and rare species of Romania (N. Boșcaiu, Gh. Coldea, C. Horeanu, 1994) [3], some threatened (E) and vulnerable (V) species were found in the flora of Câmpia Transilvaniei. There are also species included in the category of rare plants (R) which are species that are not threatened now but whose geographical distribution is restricted or run on a wider area, which are represented by populations with low strength and need protection (11 taxa).

The red list of cormophytes from Romania (M., Olteanu, G., Negrean, A., Popescu, N., Roman, G., Dihoru, V., Sanda, S., Mihăilescu, 1994) [10] presents a number of endangered, vulnerable, rare and endemic species, of which, in the Transylvania Plain a number of 34 species were found.

From the red list published by Dihoru, Gh., Dihoru, A., (1994) [5] in the Transylvania Plain flora there are found 24 taxa some of which are endangered (E), others vulnerable (V) and rare (R). Taxa suspects, which would belong to one of these three categories but for which there is insufficient data, were labeled (K).

Another recently published Red list that was considered for the analysis of flora is "Endangered Species of Carpathian List" [17]. In this list are species with strict protection (SP)

or partial protection (PP); whose zoological category is mentioned. Three species from this list can be found in the Transylvanian Plain flora. (Table 1)

Table 1: Checklist of species indicated in Red Lists and that were found in Câmpia Transilvaniei

Red list	A	B	C	D	E
Sozological category					
<i>Adonis vernalis</i> L.				V	PP-VU
<i>Adonis vologensis</i> Steven ex DC.		R	R	V	
<i>Agrimonia pilosa</i> Ledeb.	AnnIIb/R		R	R	
<i>Allium ammophilum</i> (Heuffel)			R		
<i>Allium denudatum</i> F. Delaroche (<i>Allium albidum</i> Fischer ex Bieb. ssp. <i>albidum</i>)			R		
<i>Allium flavescens</i> Besser			R		
<i>Astragalus dasyanthus</i> Pallas			R	R	
<i>Astragalus exscapus</i> L. ssp. <i>transilvanicus</i> (Barth) Jav.		R	A R	R	
<i>Centaurea trinervia</i> Willd.		R	B R	R	
<i>Cephalaria radiata</i> Griseb. et Schenk	AnnIIb/R		A R	R	
<i>Cirsium furiens</i> Griseb. et Schenk.				K	
<i>Corydalis solida</i> (L.) Clairv. ssp. <i>silvenensis</i> Velen.) Hayek			b R		
<i>Crambe tataria</i> Sebeok	AnnIIb/VU		V/R	V	
<i>Delphinium simonkaianum</i> Pawł.			A R		
<i>Dictamnus albus</i> L.			V/R		
<i>Echium maculatum</i> L.	AnnIIb/R				
<i>Epipactis palustris</i> (L.) Cr.			R		
<i>Fritillaria meleagris</i> L.		V	V/R	E	
<i>Fritillaria montana</i> Hoppe ex W.D.J. Koch			V/R	V	
<i>Galanthus nivalis</i> L.	AnnVb/VU		Nt		
<i>Gladiolus imbricatus</i> L.				R	
<i>Goniolimon tataricum</i> (L.) Boiss.				R	
<i>Gymnadenia conopsea</i> (L.) R. Br.			R		
<i>Hammarbia paludosa</i> (L.) O. Kuntze	AnnIIb/E	E	V/R	E	
<i>Inula bifrons</i> L.			R	R I	
<i>Iris aphylla</i> L. (<i>Iris hungarica</i> Waldst. et Kit.)	AnnIIb/VU				
<i>Iris sibirica</i> L.		V		R	
<i>Jurinea mollis</i> (L.) Reichenb. ssp. <i>transylvanica</i> (Spreng.) Nyman				R	
<i>Lathyrus pannonicus</i> Jacq.) Garke			R	R	
<i>Narcissus poeticus</i> L. ssp. <i>radiiflorus</i> (Salisb.) Baker (<i>Narcissus stellaris</i> Haworth).		V	V/R	R	PP-EN
<i>Nepeta ucranica</i> L.		R	V/R		
<i>Oenanthe aquatica</i> (L.) Poirer		R			
<i>Orchis coriophora</i> L.			R		
<i>Orchis morio</i> L.			R		
<i>Orchis tridentata</i> Scop. ssp. <i>tridentata</i>			R		
<i>Paeonia tenuifolia</i> L.		R	V/R	E	SP-VU
<i>Prunus tenella</i> Batsch			V		
<i>Pulsatilla pratensis</i> (L.) Mill. ssp. <i>flavescens</i> (Hazsl.) Holumb (<i>P. pratensis</i> L.) Mill. ssp. <i>hungarica</i> Soó)	AnnIIb/VU		b R	V	
<i>Pulsatilla vulgaris</i> Mill. ssp. <i>grandis</i> (Wender.) Zämel				V	

Red list	A	B	C	D	E
Sozological category					
<i>Salix rosmarinifolia</i> L.			R		
<i>Salvia transsylvanica</i> (Schur ex Griseb.) Schur			A R		
<i>Serratula coronata</i> L. (<i>Serratula wolffii</i> Andrae)			R	R	
<i>Serratula radiata</i> (Waldst. et Kit.) Bieb.			R		
<i>Silene italica</i> (L.) Pers.				K	
<i>Trinia ramosissima</i> (Fisch. ex Trevir.) W. D. J. Koch		R			
<i>Veratrum nigrum</i> L.			R		

A – Habitats Directive and OUG 57/2007

B – Red list of extincted, threatened and rare species of Romania (N.Boșcaiu, Gh. Coldea, C. Horeanu, 1994),

C – The red list of cormophytes from Romania (M.Olteanu, G.Negrean, A.Popescu, N.Roman, G. Dihoru, V. Sanda, S.Mihăilescu, 1994)

D – Rare, threatened and endemics plants in Romania's flora (Dihoru Gh., Dihoru A., 1994)

E – Carpathian List of Endangered Species

Considering these Red Lists, the report concludes that in the Transylvanian Plain flora there are currently a total of 46 taxa that are in various degrees of endangerment. It appears that most taxa belong to two sozological categories: vulnerable and rare.

The human impact in the studied area, in addition to the fact that the land it is used predominantly for agriculture increases the number of invasive species. These invasive species includes: *Amaranthus retroflexus* L. (Adv Am-N), *Amorpha fruticosa* L. (Adv, Am-N); *Acer negundo* L. (Adv Am-N); *Ailanthus altissima* (Mill.) Swingle (Adv China); *Asclepias syriaca* L. (Adv-Am-N); *Datura stramonium* L. (Adv-Am-N); *Echinocystis lobata* (Michx.) Torr. et A. Gray (*Echinocystis echinata* Britton, Sterns et Poggenb.) (Adv); *Erigeron annuus* (L.) Pers. (Adv Am-N); *Erigeron canadensis* L. Adv Am-N); *Galinsoga parviflora* Cav. Adv-Am-S; *Gleditsia triacanthos* L. Adv-Am-N); *Lycium barbarum* L. (China); *Oenothera biennis* L. (Adv Am-N); *Portulaca oleracea* L. (Asia-Temp-Adv Neophyt?); *Reynoutria sachalinensis* (F. Schmidt) Nakai (Adv-Sahalin); *Robinia pseudacacia* L. (Adv-Am-N); *Rudbeckia laciniata* L. (N-Am Adv); *Veronica persica* Poir. (Adv Asiat SV); *Xanthium spinosum* L. (Adv-Am-S); *Xanthium strumarium* L. (Cosm-Am).

The presence of the 20 invasive species, especially those that are found in significant populations may alter the natural landscape leading to the decline of native species in favor of invasive.

Conclusions

After analyzing the Transylvanian Plain flora we can say that this region is characterized by a rich and varied flora, with regional particularities and which notes the presence of important species for conservation.

Thus Balkan and Mediterranean species present confers steppic characteristic to the flora of the region.

The presence of the Daco-Balkan and Ponto-Balkan floristic elements gives a particular aspect of this area, demonstrating the intensity of their differentiation and conservation of tertiary and Pleistocene flora. The presence of some phyto-historical interference in the distant past with the Balkan Peninsula and Anatolia is attested by the presence of the Balkan species.

Due to historical conditioning from the post-glacial period, this territory has a significantly contingent of Mediterranean species.

In the Transylvania Plain flora 46 taxa are present in various degrees of endangerment. Twenty invasive species were identified.

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DIVERSITATEA FLORISTICĂ A CÂMPIEI TRANSILVANIEI (JUDEȚUL MUREȘ)

(Rezumat)

Obiectivul acestui studiu este realizarea unei analize a diversității floristice a Câmpiei Transilvaniei (județul Mureș).

Câmpia Transilvaniei se caracterizează printr-o mare diversitate de taxoni vegetali, inventarul floristic cuprinzând un număr de 716 taxoni vasculari, incluzând 692 specii, 24 subspecii și 2 forme, repartizați în 96 de familii.

A fost analizată diversitatea floristică a teritoriului studiat în ceea ce privește prezența unor specii microarealofite, endemice, specii balcanice și mediteraneene, care imprimă caracterul specific al florei Câmpiei Transilvaniei.

De asemenea, a fost semnalată prezența în cormoflora acestei regiuni a unor specii periclitare, rare, vulnerabile, care prezintă importanță comunitară sau sunt citate în listele roșii naționale (46 de taxoni).

Un segment important de plante prezente în flora Câmpiei Transilvaniei îl reprezintă și speciile invazive, a căror prezență este necesar să fie cunoscută și, de asemenea, trebuie împiedicată extinderea populațiilor acestor specii în defavoarea celor autohtone.



Fig. 1: Câmpia Transilvaniei in Mureș County



Fig. 2: A field with *Dictamnus albus* and *Echium maculatum*



Fig. 3: *Delphinium simonkaianum*



Fig. 4: *Gladiolus imbricatus*



Fig. 5: *Pulsatilla vulgaris* ssp. *grandis*



Fig. 6: *Astragalus exscapus* ssp. *transilvanicus*



Fig. 7: *Narcissus poeticus* ssp. *radiiflorus*



Fig. 8: *Veratrum nigrum*

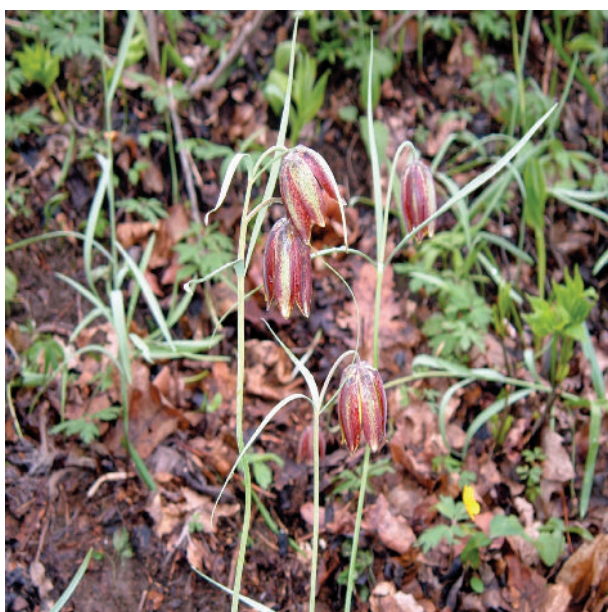


Fig. 9: *Fritillaria montana*



Fig. 10: *Salvia transsylvanica*

THE LILAC FOREST FROM PONOARELE. PHYTOSOCIOLOGIC CONSIDERATIONS

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Abstract: This article discusses the similarities between the Syringo-Fraxinetum orni association (Ponoarele) and the Syringo-Carpinetum orientalis association (Danube Defile) in terms of bioforms, ecological indices, karyology, geoelementes.

Keywords: phytosociology, plant associations, Ponoarele, Danube Defile

Introduction

Located in the continental bioregion, where the landform monotony usually prevails, when speaking about Plateau Mehedinți Geopark – one can notice a strong swerve away from the foreseeable, the variety of the micro-landforms meeting no limits. The particular local characteristics determined the setting, development and maintenance of enormous biotope richness, as well as of a complex biotic constituent.

The Natural Bridge from Ponoarele imposes itself through its massive structure, built of 1–2 meters of laminated chalk and having 30 meters length, 13 meters width, 22 m height and 9 meters depth as dimensions. This fabulous edifice represents a vestige of Podului Cave, which has been isolated from the current entrance in the cave through a vast “dolina” – Crovul Peșterii – formed through the crumbling of a 50 meters portion of an old tunnel’s ceiling.

The cave from Pod is complex, having numerous floors and 2 entrances. The entrance from Natural Bridge is 15 meters wide and 3 meters high, allowing access towards a descending tunnel on the first 50 meters, which then turns subhorizontal. The total length is 734 meters. The tunnel has enormous dimensions: 10–12 meters width and 5–8 meters height. The tunnel actually represents the main gallery built under the rocks. From this gallery – the Fossil Gallery is born.

“Lapiezurile de la Ponoare” are the most imposing karst phenomena of this type in Romania. The “lapiez” fields amaze through their beauty and uniqueness. The chalk boards are furrowed by “canels” of 4–5 meters, 15–20 meters depth.

“Zătonul Mare, The Ghost Lake, which is sometimes full of water, offers the human eyes a wide mirror. Some other times, it’s hollow, deserted, crimson and cleft – the ideal scenery for a film about another planet” (Lascu, 1982) – Hiking through Mehedinți Mountains [7].

Material and methods

This research is based on field observation. The main method of study was the most frequent and appreciable of Montpellier School, the Braun-Blanquet method.

For each syntaxonomic unit, territorial spreading, floristical composition, biological structure, phytogeographic elements and ecological behavior correlated with plants' needs for humidity, temperature and soil pH are mentioned in the paper. A diploid and polyploid species graphic distribution was made as well.

Results and discussions

Cls. Quercetea pubescenti-petraeae (Oberd. 1948, 1957) Jakucs 1961

Ord. Orno-Cotinetalia Jakucs 1961

Al. Syringo-Carpinion orientalis Jakucs 1961

Ass. Syringo-Fraxinetum orni Borza 1958

The lilac forest from Ponoarele (*Syringo-Fraxinetum orni*) shows resemblance of Balkan "sibliacuri" (*Syringo-Carpinetum orientalis*), reflecting the conditions of a submediterranean climate ideal for Balkan – Illyrian elements.

In the phytogeographical assignation written by Al. Borza (1931, 1957, 1965), the Ponoarele territory is located at the crossroad between the Banatului constituency and the Getic constituency of Oltenia, which belong to the Dacian-Illyrian province, from the euro-Siberian region.

Comparing the bioforms spectrums of the 2 associations (Fig. 1; Fig. 2), one can notice the predominance of hemicryptophytes (47%).

Regarding the rest of bioforms, a slight difference can be noticed:

- phanerophytes are more numerous when it comes to ass. *Syringo-Fraxinetum orni* (21%) compared to ass. *Syringo-Carpinetum orientalis* (18%)
- geophytes from ass. *Syringo-Fraxinetum orni* (19%) are better represented than ass. *Syringo-Carpinetum orientalis* (7%)
- therophytes from ass. *Syringo-Fraxinetum orni* (8%) are weaker in representation compared to ass. *Syringo-Carpinetum orientalis* (20%).

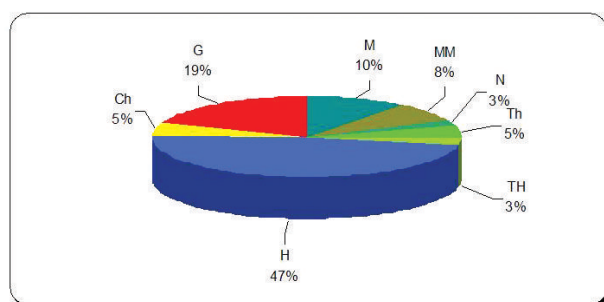


Fig. 1: Bioforms spectrum of *Syringo-Fraxinetum orni* association

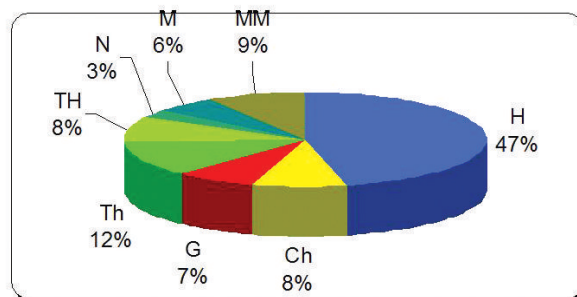


Fig. 2: Bioforms spectrum of *Syringo-Carpinetum orientalis* association (Matacă, 2005)

Regarding the ecologic clues, we can notice a resemblance between the 2 associations (Fig. 3; Fig. 4):

- by humidity: xero-mesophilic species (ass. *Syringo-Fraxinetum orni* – 41.33%; ass. *Syringo-Carpinetum orientalis* – 49.72%) and xerophilic species (ass. *Syringo-Fraxinetum orni* – 42.66%; ass. *Syringo-Carpinetum orientalis* – 19.55%).
- by temperature: micro-mesotherms species (ass. *Syringo-Fraxinetum orni* – 62.33%; ass. *Syringo-Carpinetum orientalis* – 58.65%) and moderate-thermophilic species (ass. *Syringo-Fraxinetum orni* – 15.58%; ass. *Syringo-Carpinetum orientalis* – 28.49%).

– by the soil reaction, within both associations, the low-acid-neutrophilous species are more numerous (ass. *Syringo-Fraxinetum orni* – 52.63%; ass. *Syringo-Carpinetum orientalis* – 60.89%).

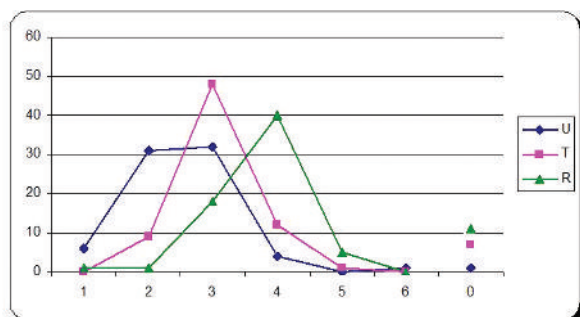


Fig. 3: Ecological indices of *Syringo-Fraxinetum orni* association

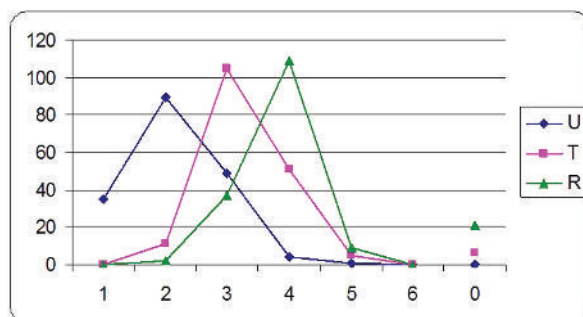


Fig. 4: Ecological indices of *Syringo-Carpinetum orientalis* association (Matacă, 2005)

Out of 77 species (*Syringo-Fraxinetum orni* association), 50% are diploid, 39% of them are polyploid, 5% of them are diplo-polyploid species and for 5 species the number of chromosomes hasn't been identified (Fig. 5). The diploid index (I.D. = 1.26) shows the relict character of the association.

Out of 179 species (*Syringo-Carpinetum orientalis* association), 44.69% are diploid, 36.87% are polyploid, 2.79% are diplo-polyploid and for 28 species the number of chromosomes hasn't been identified (Fig. 6). The diploid index (I.D. = 1.56) confirms the relict character and concurs with the chorologic situation of the association.

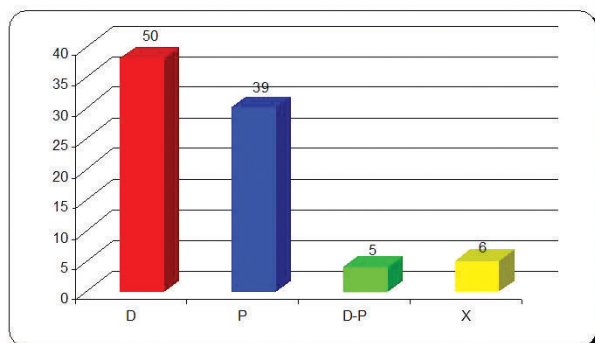


Fig. 5: Karyological spectrum of *Syringo-Fraxinetum orni* association

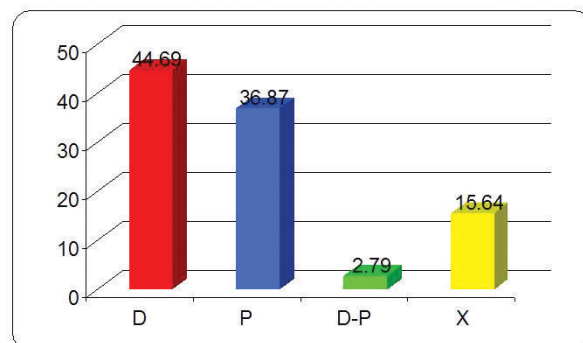


Fig. 6: Karyological spectrum of *Syringo-Carpinetum orientalis* association (Matacă, 2005)

Within the floristic elements' spectrum of *Syringo-Fraxinetum orni* association (Fig. 7), along with the Eurasian (33%) and European (19%) species, the significant presence of the Mediterranean species (16%) is noticed, followed by the Balkan (4%) and Dacian species (4%).

Within the floristic elements' spectrum of *Syringo-Carpinetum orientalis* association (Fig. 8), along with the Eurasian (27%) and European (14%) species, the significant presence of the Mediterranean species (13%) is noticed, as well as the Pontic (11%) and Balkan (10%), followed by the Carpathian (5%) and Dacian (4%) species.

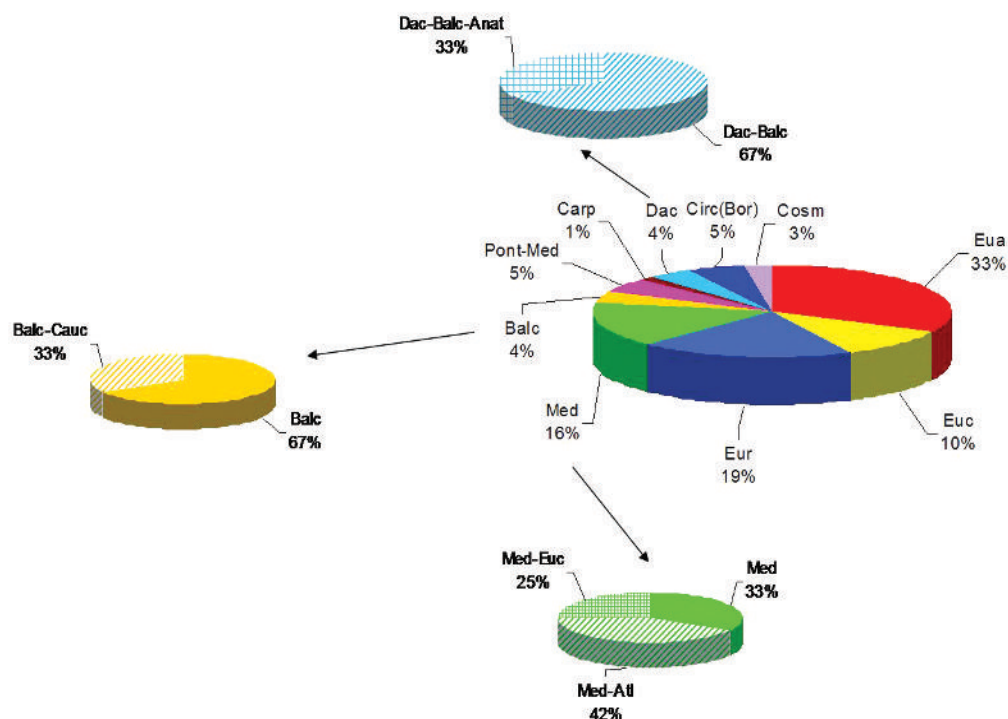


Fig. 7: The floristic elements' spectrum of *Syringo-Fraxinetum orni* association

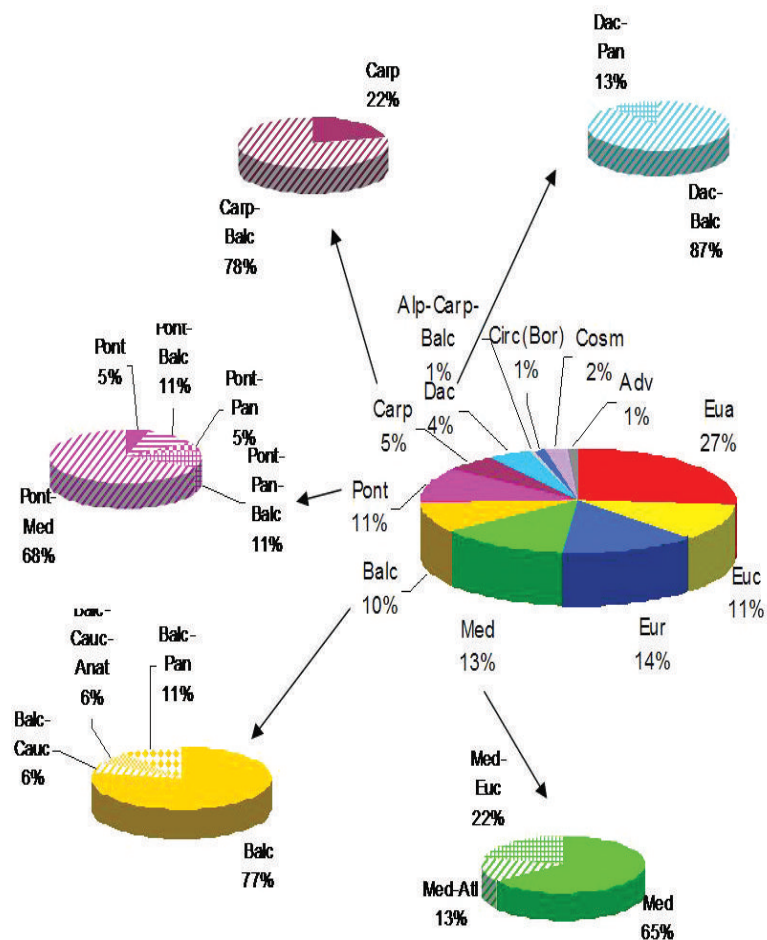


Fig. 8: The floristic elements' spectrum of *Syringo-Carpinetum orientalis* association (Matacă, 2005)

Table 1: Ass. *Syringo-Fraxinetum orni* Borza 1958

Fb.	E.f.	Cyt.	Releve Exposition Inclination (°) Covering (%) Surface (m ²)	1 SW 10 90 400	2 SW 10 90 400	3 SW 10 80 400	4 SW 10 90 400	5 SW 10 80 400	K
M	Dac-Balc	D	<i>Syringa vulgaris</i>	4	4	4	3	4	V
MM	Med	D	<i>Fraxinus ornus</i>	3	2	2	2	2	V
			Syringo-Carpinion orientalis						
H	Pont-Med	D	<i>Lathyrus venetus</i>	+	+	+	+	+	V
MM	Balc-Cauc	D	<i>Carpinus orientalis</i>	+	+	+	-	+	IV
H	Dac-Balc	-	<i>Euphorbia lingulata</i>	+	+	-	-	-	II
G	Euc	P	<i>Arum alpinum</i>	-	-	+	+	-	II
			<i>Orno-Cotinetalia</i>						
H	Balc	D	<i>Calamintha alpina</i>	-	-	+	+	+	III
G	Med-Atl	P	<i>Tamus communis</i>	-	+	+	-	-	II
G	Med-Atl	D	<i>Orchis simia</i>	-	-	+	+	-	II
H	Eua(Med)	D	<i>Silene italica</i>	+	-	-	+	-	II
			Quercion farnetto						
H	Med-Euc	D	<i>Potentilla micrantha</i>	+	+	+	+	+	V
H	Med	D	<i>Lychnis coronaria</i>	+	+	+	+	+	V
MM	Balc	-	<i>Quercus farnetto</i>	+	+	-	-	+	III
			Quercetea pubescenti-petraeae						
M	Pont-Med-Euc	D-P	<i>Cornus mas</i>	+	+	+	+	+	V
M	Eur	D	<i>Crataegus monogyna</i>	+	+	+	+	+	V
H	Eua(Med)	P	<i>Geum urbanum</i>	+	+	+	+	+	V
H	Eua	D	<i>Fragaria vesca</i>	+	+	+	-	+	IV
H-Ch	Pont-Med	P	<i>Glechoma hirsuta</i>	+	+	-	+	+	IV
Ch	Euc-Med	P	<i>Teucrium chamaedrys</i>	+	+	+	-	+	IV
H(Ch)	Eua	P	<i>Veronica chamaedrys</i>	+	+	-	+	+	IV
H	Med-Atl	P	<i>Viola odorata</i>	+	+	+	-	+	IV
H(G)	Eua(Med)	P	<i>Sedum maximum</i>	+	+	+	-	+	IV
M	Euc	D	<i>Cornus sanguinea</i>	+	+	-	+	+	IV
MM-M	Eur	D	<i>Acer campestre</i>	+	+	-	+	-	III
N	Eur	P	<i>Rosa canina</i>	+	-	-	+	+	III
TH(H)	Eua(Med)	D-P	<i>Arabis hirsuta</i>	+	+	+	-	-	III
H	Eua(Med)	D	<i>Brachypodium silvaticum</i>	-	+	+	+	-	III
H	Eur	P	<i>Digitalis grandiflora</i>	+	+	-	-	+	III
H	Eur	P	<i>Galium album</i>	+	+	-	+	-	III
H-G	Eur	D	<i>Melica uniflora</i>	-	+	+	-	+	III
H	Eua(Med)	-	<i>Melittis melissophyllum</i>	-	+	+	-	+	III
TH(H)	Euc(Med)	D	<i>Arabis turrita</i>	-	+	+	-	+	III
MM(M)	Eur	D	<i>Quercus petraea</i>	-	-	+	+	-	II
M	Eur	D	<i>Corylus avellana</i>	-	+	-	+	-	II
MM	Eur(Med)	D	<i>Sorbus torminalis</i>	+	+	-	-	-	II
M	Med-Euc	D	<i>Viburnum lantana</i>	-	-	+	+	-	II
H	Eua(Med)	D	<i>Astragalus glycyphyllos</i>	-	-	+	+	-	II
H	Eua(Med)	D	<i>Campanula persicifolia</i>	-	-	+	+	-	II
H	Eua(Med)	P	<i>Campanula rapunculoides</i>	-	-	+	+	-	II
H	Euc-Med	P	<i>Calamintha sylvatica</i>	-	+	-	-	+	II
H	Eur(Med)	D	<i>Cynanchum vincetoxicum</i>	-	+	-	-	+	II
Th(TH-H)	Euc	D-P	<i>Cardaminopsis arenosa</i>	-	-	+	+	-	II
H	Eur	P	<i>Carex bullockiana</i>	-	-	+	-	+	II

F.b.	E.f.	Cyt.	Releve Exposition Inclination (°) Covering (%) Surface (m ²)	1 SW 10 90 400	2 SW 10 90 400	3 SW 10 80 400	4 SW 10 90 400	5 SW 10 80 400	K
G	Eua(Med)	D	<i>Polygonatum odoratum</i>	-	-	+	-	+	II
H	Eua	D-P	<i>Filipendula vulgaris</i>	-	-	+	+	-	II
			Quercetalia petraeae-pubescenti						
H	Eua	P	<i>Cruciata pilosa</i>	-	+	-	-	+	II
H	Eua(Cont)	D	<i>Hypochoeris maculate</i>	+	-	+	-	-	II
M-MM	Med	D	<i>Prunus mahaleb</i>	-	-	+	-	-	I
			Fagetalia						
G	Eur	P	<i>Corydalis solida</i>	+	+	+	-	+	IV
G	Euc	D	<i>Isopyrum thalictroides</i>	+	+	+	-	+	IV
G	Eur	P	<i>Anemone rapunculoides</i>	+	-	-	+	+	III
G	Euc	P	<i>Cardamine bulbifera</i>	-	+	+	+	-	III
Ch	Eur(Med)	D	<i>Euphorbia amygdaloides</i>	-	+	+	-	+	III
G	Carp	D	<i>Hepatica nobilis</i>	-	-	+	+	+	III
H(G)	Circ(Bor)	P	<i>Adoxa moschatellina</i>	-	+	+	-	-	II
G	Circ(Bor)	P	<i>Anemone nemorosa</i>	-	+	-	+	-	II
H	Med	P	<i>Aremonia agrimonoides</i>	-	+	+	-	-	II
N-E	Med-Atl	P	<i>Hedera helix</i>	-	+	-	+	-	II
Ch	Eur(Mont)	D	<i>Saxifraga rotundifolia</i>	-	-	-	+	-	I
			Carpinion dacicum						
H	Balc	P	<i>Helleborus odoratus</i>	-	+	+	+	-	III
MM(M)	Eur	P	<i>Carpinus betulus</i>	-	+	-	+	-	II
G	Eua	D	<i>Erythronium dens-canis</i>	+	-	-	+	-	II
			Asplenietalia rutae-murariae (incl. Asplenietea)						
H	Cosm	P	<i>Asplenium trichomanes</i>	+	-	+	+	+	IV
H	Cosm	P	<i>Cystopteris fragilis</i>	+	+	-	+	-	III
H	Circ(Bor)	P	<i>Asplenium ruta-muraria</i>	-	+	-	+	-	II
H	Med-Atl	P	<i>Asplenium ceterach</i>	-	+	-	+	-	II
H	Euc(Mont)	D	<i>Moehringia muscosa</i>	-	-	+	-	+	II
Ch	Eua	P	<i>Sedum album</i>	-	+	-	-	+	II
			Variae Syntaxa						
H	Eua(Med)	P	<i>Veronica teucrium</i>	+	+	-	+	+	IV
H	Eua	D	<i>Poa angustifolia</i>	+	-	+	-	+	III
G	Pont-Med	D	<i>Ornithogalum orthophyllum</i>	+	+	-	+	-	III
Th-TH	Eua(Med)	D	<i>Geranium lucidum</i>	-	-	+	-	+	II
G	Circ(Bor)	P	<i>Ophioglossum vulgatum</i>	-	-	-	+	-	I
Th	Dac-Balc-Anat	-	<i>Rhinanthus rumelicus</i>	-	-	+	+	+	III
H	Eua(Med)	D	<i>Campanula trachelium</i>	-	+	-	-	+	II
H	Pont-Med	D	<i>Scutellaria altissima</i>	-	+	-	+	-	II
Th	Eua	D	<i>Saxifraga tridactylites</i>	+	-	-	-	-	I

Conclusions

The current area of the lilac forest surrounds Serbia's East, Romania's West, Bulgaria, European Turkey and a small region of Little Asia. Even without phytopaleontological proof, it is admitted that the arcto-tertiary area of *Syringa vulgaris* species, emerged from a genetic tropical center, had to be wider [5, 10].

Once the tertiary climate cooled down, the lilac forest area had been gradually limited in South-East Europe. During the glacial times, the area of this species had been pushed more and more towards the South, where it survived until this day within its Balkan haven that had been left out of the glacial climate's influence. The pre-glacial origins of the lilac coenoses from the Balkan resorts remain beyond any doubt [10].

"Șibliacurile" from Danube Defile, which represent continental xerotherme forests and prolonged bush ecosystems from the center and East of Balkan Peninsula (Moesicum), have been welcomed in the Syringo-Carpinion *orientalis* Jakucs alliance 1959. It is still difficult to distinguish the secondary "șibliacuri", developed as a consequence of the deforestation of the primary ones, which can be found on the chalk steep surfaces maintained young through neotectonic processes[8].

The similarities of the "șibliacuri" from Danube Defile and the ones that R. Knapp (1944) studied on Valea Timokului confirm the syngenetic bonds of these "șibliacuri" and also show the seniority of the clusters emerged during interglacial xerotherme periods of [4].

The most obvious coenologic affinities of ass. Syringo-Fraxinetum *orni* (Ponoarele) can be seen with ass. Asplenio-Syringetum, which possesses less representative fragments that are noticed within the analyzed clusters, blossoming through the deep cliffs. Within its structure, ass. Syringo-Fraxinetum *orni* stays definite from ass. Asplenio-Syringetum, which usually colonizes the steep, rocky walls. The syngenetic bonds of the 2 associations stay obvious [9].

The thermal features of the chalk substrate, on which the most Northern lilac population grows, can be found in our country militating for their relictar, even preglacial, character. The ecologic conditions of the Ponoarele station, sheltered by Mehedinți ridges against the cold winds during glacial periods of time, could have been ideal for the survival of a lilac population from the preglacial periods, or even from the end of the tertiary.

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PĂDUREA DE LILIAȘ DE LA PONOARELE. CONSIDERAȚII FITOSOCIOLOGICE (Rezumat)

Lucrarea analizează similaritățile dintre asociațiile Syringo-Fraxinetum *orni* (Ponoarele) și Syringo-Carpinetum *orientalis* (Defileul Dunării) din punct de vedere a compoziției floristice, bioformelor, geoelementelor, preferințelor ecologice a speciilor componente și cariologic.

CONSIDERATIONS CONCERNING THREATENED CORMOFLORE FROM GRĂDIȘTEA MUNCULUI-CIOCLOVINA NATURAL PARK

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Abstract: In this paper is realized a characterization of zoological categories from Grădiștea Muncelui-Cioclovina Natural Park. On the basis of personal investigation on field and data from the literature we mention 53 plant species that are classified in four zoological categories (vulnerable, rare, vulnerable/rare and not threatened).

Keywords: cormophytes, threatened, Grădiștea Muncelui-Cioclovina Natural Park

Introduction

Grădiștea Muncelui Cioclovina Natural Park is a protected area with the status of natural park, with a surface of about 38116 hectares, that is overlapping with a Site of Community Importance ROSCI0087 established by Ministerial Order no. 1964/2007 and a Special Protection Area ROSPA0045 established by Government Decision no. 1284/2007. The conservation objective for which were established these sites is maintenance or restoration at a favorable conservation status of 13 habitats of community interest and 106 species of community interest (10 species of mammals, 2 species of amphibians, 4 species of fish, 79 species of birds, 9 species of invertebrates and 2 plants species).

In the past there have been made studies concerning flora and vegetation on this territory by Balazs [1], Boșcaiu *et* Peterfi [2], Vințan *et* Burescu [8, 9].

Geologically, this area belongs to Getic Domain composed of Upper Precambrian metamorphic rocks (crystalline schist, granite, limestone, sandstone). Water network is very extensive, the streams discharging into two main rivers Grădiște and Strei. The climatic conditions of the area can be characterized globally by an average annual temperature of 3–7° C, with variations depending on altitude and an average annual of rainfall that varies between 550–600 mm (in north, west and south) and exceeding 1000 mm in areas with altitudes above 1700 m. Regarding the wind regime, in the northern part of the park, western winds have a higher frequency, channeled on the Mureș corridor, but in southeast predominate winds from south and north.

Material and methods

The floriferous inventory was realized both on basis of own researches in the field and the information from literature [1, 2, 8, 9, 10]. The scientific names of plants species have been

validated according to database developed by the Kew Royal Botanical Garden-England and Missouri Botanical Garden-USA (The Plant List-<http://www.theplantlist.org/>). The sozological categories were established using National Red List [3, 5] and were analyzed taxonomically and from the point of view of the bioforms, floristic elements and ecological preferences.

Results and discussions

Floristic inventory: Orchidaceae (*Anacamptis pyramidalis*, *A. coriophora*, *A. morio*, *A. laxiflora*, *Cephalanthera damasonium*, *C. longifolia*, *C. rubra*, *Corallorrhiza trifida*, *Dactylorhiza incarnata*, *D. maculata*, *D. sambucina*, *D. viridis*, *Epipactis helleborine*, *E. microphylla*, *Gymnadenia conopsea*, *Herminium monorchis*, *Limodorum abortivum*, *Neottia nidus-avis*, *N. ovata*, *O. mascula* ssp. *signifera*, *Neotinea ustulata*, *N. tridentata*, *Platanthera bifolia*, *P. chlorantha*, *Spiranthes spiralis*), Dipsacaceae (*Cephalaria radiata*, *C. laevigata*), Caryophyllaceae (*Dianthus spiculifolius*, *Silene borysthena*), Amaryllidaceae (*Galanthus nivalis*), Ranunculaceae (*Hepatica transsilvanica*, *Pulsatilla patens*), Cupressaceae (*Juniperus sabina*), Plantaginaceae (*Plantago holosteum*), Crassulaceae (*Sempervivum marmoreum*, *S. montanum*), Rosaceae (*Sorbus dacica*, *S. borbasii*), Taxaceae (*Taxus baccata*), Lamiaceae (*Thymus comosus*), Scrophulariaceae (*Tozzia carpathica*, *Scrophularia heterophylla* ssp. *laciniata*, *Veronica bachofenii*), Saxifragaceae (*Saxifraga pedemontana*), Rutaceae (*Dictamnus albus*), Apiaceae (*Peucedanum rochelium*), Valerianaceae (*Valeriana dioica* ssp. *simplicifolia*), Asteraceae (*Arnica montana*, *Anthemis cretica*, *Doronicum carpatum*), Alliaceae (*Allium carinatum* ssp. *pulchellum*), Poaceae (*Piptatherum virescens*, *Festuca panciciana*).

The floristic researches achieved in Grădiștea Muncelului Cioclovina Natural Park have been materialized with the identification of 53 species of different sozological categories belonging to 38 genus and 19 families. The *Orchidaceae* family has the most species of cormophytes (25 sp.—47,16%). We may consider this park as a heaven for orchids because these species have dozens or hundred of individuals in some areas (especially in forests, grasslands, edge of bushes). The *Asteraceae* and *Scrophulariaceae* families are represented by three species (each of them with 5,76%), while the *Poaceae*, *Rosaceae*, *Ranunculaceae*, *Crassulaceae*, *Caryophyllaceae* and *Dipsacaceae* families have only two species each of them (3,84%) (fig. 1).

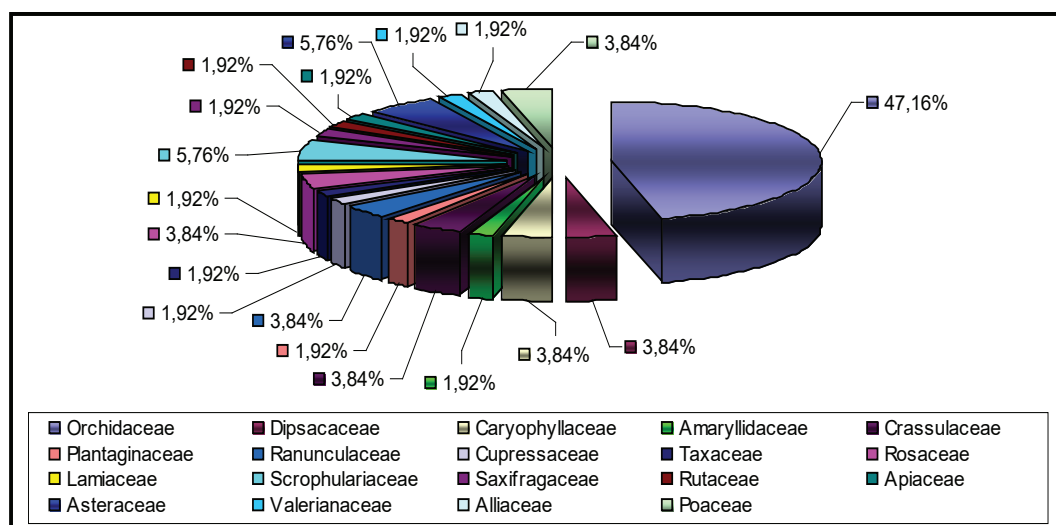


Fig. 1: Distribution of cormophytes families

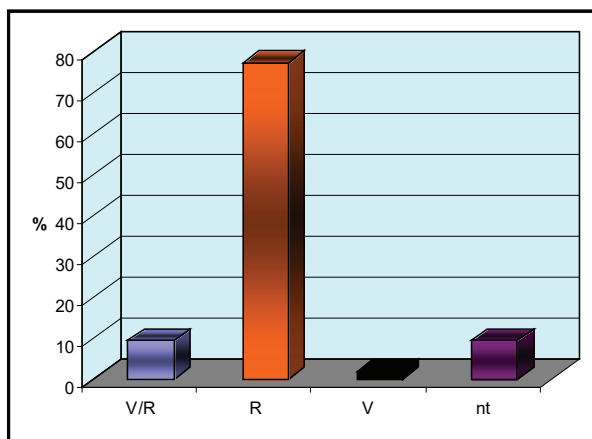


Fig. 2: Distribution of sozological categories

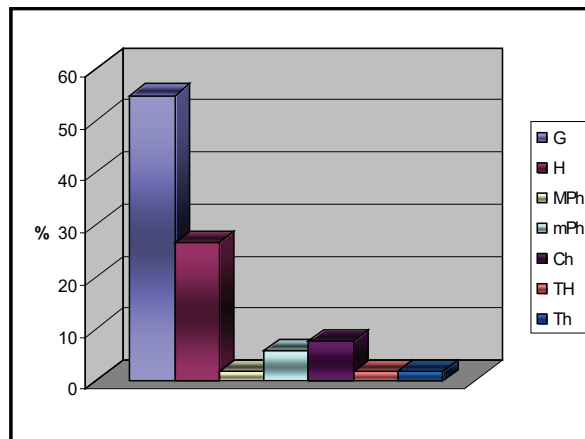


Fig. 3: Bioforms spectrum of sozological categories

The most numerous group consists of rare species (77,35%), followed by vulnerable/rare (9,43%), not threatened (9,43%) and vulnerable species (1,88%) according to Red List of the superior plants of Romania (Oltean *et al.*, 1994) [5] (fig. 2).

From the point of view of life forms, geophytes register the highest percentage (54,71%), while hemicryptophytes represent only 26,41%. The species that have the resting buds near the ground (chamaephytes) and those with buds on braches above the ground (phanerophytes) present a rate of 7,54%. The annual and perennial therophytes have a percentage of 3,76% from the all bioforms (fig. 3).

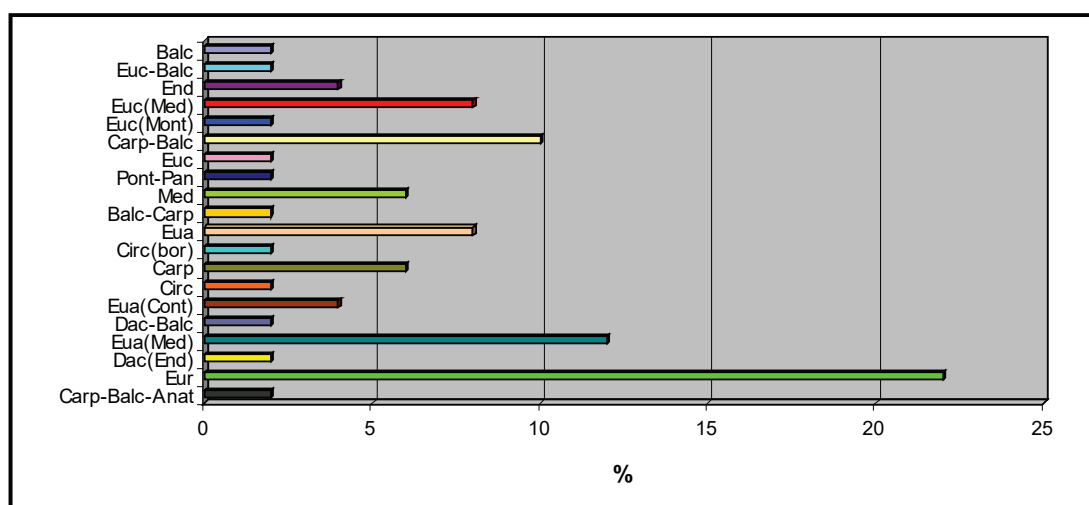


Fig. 4: Floristic spectrum of sozological categories

The basic fund of the goeelements includes European (22%), Eurasian-Mediterranean (12%) and Balkan-Carpathian (10%) species (fig. 4). There are also taxons with phytogeographical importance as Dacian-Endemic (*Cephalaria radiata*), Dacian-Balkan (*Peucedanum rochelianum*), Carpathian (*Thymus comosus*, *Hepatica transsilvanica*, *Dianthus spiculifolius*) and Endemic (*Sorbus borbasii*, *S. dacica*) elements. The mild climate in some areas from the park favored the development of the Mediterranean species as *Orchis mascula* ssp. *signifera*, *Anthemis cretica*, *Piptatherum virescens*.

Analyzing the ecological preferences of species for humidity, temperature and soil reaction we noticed the dominance of xeromesophilous (52%), micro-mesothermal (50%) and low acid-neutrophilous (52%) species (fig. 5).

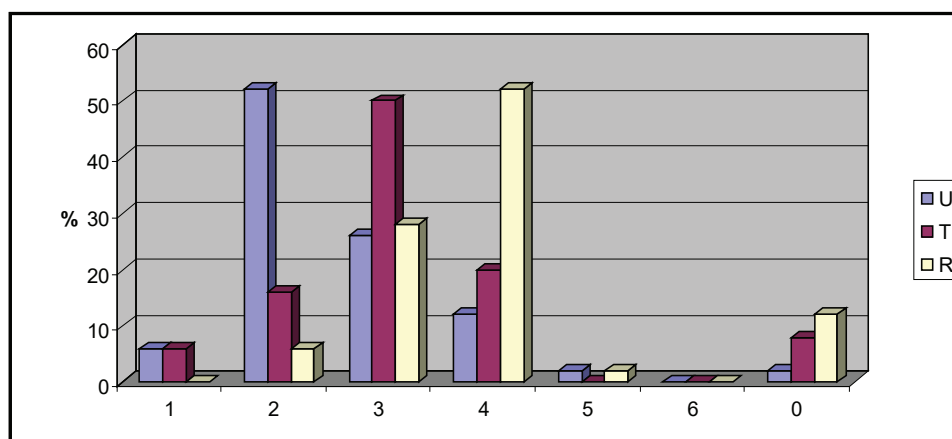


Fig. 5: Ecological indices of sozological categories



Photo 1, a: *Platanthera bifolia* (L.) Rich.; b: *Spiranthes spiralis* (L.) Chevall.; c: *Neottia nidus-avis* (L.) Rich.



Photo 2, a: *Campanula serrata* (Kit.) Hendrych; b: *Arnica montana* L.

Conclusions

The floristic researches achieved in Grădiştea Muncelului Cioclovina Natural Park have been materialized with the identification of 53 species that belong to different zoological categories (rare, vulnerable, vulnerable/rare, not threatened). The most numerous species belong to *Orchidaceae* family and because they have a high density in some habitats we consider this park a heaven for orchids.

Some species are mentioned in national (OUG 57/2007, Red List of the superior plants of Romania) and international documents (Habitats Directive 92/43/EEC, Bern Convention) such as: *Arnica montana*, *Pulsatilla patens*, *Campanula serrata*, *C. abietina*, *Galanthus nivalis*, *Tozzia carpathica*.

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CONSIDERAŢII PRIVIND CORMOFLORA PERICLITATĂ A PARCULUI NATURAL GRĂDIŞTEA MUNCELULUI CIOCLOVINA (Rezumat)

În această lucrare este realizată o caracterizare a categoriilor zoologice din Parcul Natural Grădiştea Muncelului-Cioclovina. Pe baza cercetărilor proprii în teren, cât şi a datelor din literatura de specialitate, menţionăm 53 de specii de cormofite clasificate în patru categorii zoologice (rare, vulnerabile, vulnerabile/rare şi neameninţate).

ANTIBACTERIAL ACTIVITY OF COMPOUNDS DERIVED FROM HIDROETHANOLIC EXTRACTS OF *JUGLANS NIGRA*

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Abstract: Wooden objects with heritage value, both exposed to the external environment and the enclosed spaces are often exposed to both fungal and bacterial attack. Degradation often occurs while no visible exterior but may have irreversible effect. Usually, the bacteria that attack the wood does not have action against of human body. However, there have been reported some cases of the patients with infections caused by phytopathogenic bacteria. The aim of the study was to test active compounds of the hydroethanolic extract of *Juglans nigra* against phytopathogenic bacteria with implication also on the human body. The active compounds with antibacterial activity have been identified and separated by thin-layer chromatography (TLC). MCI of the hydroethanolic extract of *Juglans nigra* had values between 15,625 µg / mL and 250 µg / mL. In conclusion, we can say that these extracts can be used successfully against bacterial pathogens.

Keywords: *Juglans nigra*, antibacterial compounds, Gram positive and Gram negative bacteria

Introduction

Both Gram-positive and Gram negative bacteria were reportated as having degrade wood. Favoring factors colonization in wood polymer are numerous, these being found in both water and soil and in the air. *Bacillus* spp. are a diverse group of bacteria widely distributed in soil and aquatic medium, implications for wood degradation. They are aerobic Gram positive bacteria, endospore-forming in the form of rods being the most common soil microorganisms. Due to their ability in forming the spores, they are resistant to a range of varying conditions of the environment and they adapt easily to different habitats. On the basis of 16S rDNA sequence analysis, have been identified *Bacillus subtilis*, *B. amyloliquefaciens*, *B. pumilus* and *B. atrophaeus*. Recently, it was reported that *B. pumilus* is the second most prevalent species *Bacillus*. This bacteria is highly resistant to extreme environmental conditions, such as reduced availability of nutrients or lack thereof, dryness, radiation, H₂O₂ and chemical disinfection. Some strains of *B. pumilus* with habitat in soil colonize the roots of plants having an ecological role in produce compounds for fungal and bacterial antagonists. *B. pumilus* has a role to ensure

the nitrogen is able to convert molecular nitrogen (N_2), into ammonia (NH_3) [4, 9]. *B. pumilus* are important agents due to the proteases they produce and which are used in the chemical, food, pharmaceutical and / or presents a serious problem in the quality assurance of these industry segments. Less frequently *B. pumilus* isolated was also involved in food toxicity and in human infections, including skin lesions similar those produced by the *B. anthracis* [2]. In 2006, there were reported three cases of infection with *B. pumilus*. Strain isolated produced a lipopeptide complex (pumilacidins), known to have toxic effects on human epithelial cells. Symptoms have manifested as dizziness, headache, chills, back pain, stomach cramps, diarrhea [3]. Tena (2007) reported in an article, 3 cases of patients, the same family of shepherds, with skin lesions produced by *B. pumilus* [13]. The treatment consisted of amoxiclav and in one case, with ciprofloxacin for long-term. Thus, *B. pumilus* research is of considerable interest to understand the physiological diversity, genetic correlation with other *Bacillus spp.* and possibly the presence of toxicity-genes.

B. subtilis is an aerobic ubiquitous microorganism, but can live also in anaerobic conditions by using nitrate or nitrite as a terminal electron acceptor or by fermentation in the absence of electrons using pyruvate dehydrogenase for pyruvate metabolize [6]. Pyruvate formed in glycolysis penetrates the mitochondria (transportation) and undergoes oxidative decarboxylation to acetyl CoA (pyruvate dehydrogenase complex). Acetyl CoA is totally oxidized (NAD^+ and FAD) in tricarboxylic acid cycle (TCA) to form CO_2 , NADH, FADH₂, ATP [Jelea, 2015]. *B. subtilis* produces a variety of proteases and other enzymes that facilitate the degradation of the natural variety of substrates. *Bacillus* appears in a population of 106–107 per gram of the soil. It is estimated that 60% of existing soil bacillus is dormant spore form [1]. In order to determine the mode of action of *B. subtilis* on the wood, numerous experiments have been made by subjecting the wood to non-sterile water or direct bacterial attack. Following the analysis of results it was found that *B. subtilis* acts only on sapwood, compared with *Trichoderma viride* which act on the heartwood. As biotechnologies *B. subtilis* is used to increase the permeability of wood prior to use spray with protective role [8, 10].

The general principle in changing the chemical composition of wood is a chemical reaction with functional groups (mainly hydroxyl groups) of cell wall polymers (cellulose, hemicellulose, lignin) and covalent crosslinkage. They lead to changing the chemical and physical characteristics of wood [11]. Through introduction of consistent groups of cell walls, the cell wall growth and pore size decreases [1993]. Therefore, the moisture content decreases of the equilibrium because the available space between the cell wall polymers decreases and no longer includes water molecules. High resistance against attack of bacteria or fungi is assumed to be rather due to changes in the chemical properties of the wood structure, than a consequence of the toxic effect against them. Changes in the composition are not toxic wood degrading organisms but prevent their colonization [11].

Cellulose is the main component of the plant cell wall. Cellulases are groups of enzymes involved in conversion of cellulosic substrates by fermenting sugars. The most important are: endoglucanase (EC 3.2.1.4), exoglucanase or celobiohydrolase (EC 3.2.1.91) and β – glucosidase (EC 3.2.1.21). Endoglucanase hydrolyze β – 1,4 in the cellulose molecule, whereas exoglucanase cleaved the ends to release cellobiose, and β – glucosidase and converts cellobiose to glucose. *Bacillus spp.*, *Clostridium spp.*, *Cellulomonas spp.*, *Thermomonospora spp.*, *Ruminococcus spp.*, *Bacteroides spp.*, *Erwinia spp.* and *Acetivibrio spp.* were identified as producing cellulases.

The isolation and characterization of new enzymes that hydrolyze cellulose from bacteria, is still a very active research domain because the bacteria have a growth rate higher than the mushrooms, which leads to greater production of enzymes [Singh, 2013].

Pseudomonas syringae, Gram negative bacteria, phytopathogenic, facultative anaerobic, has been isolated from soil as a saprophyte on decomposing organisms. *Syringae* denomination derives from the name of tree lilac (*Syringa vulgaris*) from which was first isolated. For an optimal development, it was needed a high humidity and temperature between 12–25 °C. Its action is manifested by staining wood and producing ulcers compared with *Pseudomonas tumefaciens* that produce tumors wood. In some cases, the pathogenesis produced by these bacteria can easily be confused with the one produced by fungi such as *Cytospora spp.* or *Dothichiza spp.* also producing wood staining olive green and then yellowish-orange neconturate. On these spots appear fructification but without producing suppuration. Due to the bacterian attack, the wood is split thus enabling the fungal and xylophagous attack. The bacteria do not attack cellulose. These bacteria act only on the pectin. Due to cambium destruction, deformation is produced of wood [5].

Materials and methods

In order to study the antibacterial activity of the extract of *Juglans nigra* Hydroethanolic, we selected two species of Gram-positive bacteria (*Bacillus pumilus* and *B. subtilis*) and Gram-negative species (*Pseudomonas syringae*), which were isolated on the surface of contaminated wood.

Strains identification was made by means of automatic method VITEK® 2.

Detection of soluble virulence factors

We used specific mediums to highlight the external enzyme production. Also, we used to detect gelatinase nutrient agar medium with gelatin. The positive reaction occurs as a result of precipitation marked by a halo around the colonies due to hydrolysis of gelatin. In order to detect caseinase, we used simple agar medium with the addition of milk. The test is considered positive when around the colonies an ivory precipitate forms to calcium paracaseinat. DN-ase acts on the microbial DNA releasing mono- or dinucleotides. It is used the DNA agar with or without toluidine blue. Agar is inoculated into streaks or spots, and the hydrolysis of the DNA is revealed by the appearance of a pink halo around the spot of culture, while the remainder of the medium remains colored in blue. We also use agar medium with the addition of TWEEN 80, 60 or 40, to detect lecithinase. The presence of lecithinase lead to the appearance of insoluble oleate crystals Ca^{2+} (crystals formed from the released fatty acids and Ca^{2+}).

Hydroethanolic extraction of *Juglans nigra*

Juglans nigra leaves were harvested in May and June in Botanical Garden Bucharest. After drying, 300 g of milled plant were macerated in 700 mL of ethanol-water (v / w 5: 2). The solutions were prepared in an amber glass which was stored in the dark at 4°C for a period of 10 days, being agitated every day. After 10 days, the macerate of the plant was placed in a rotary evaporator for 10–15 minutes after which the supernatant was removed using a filter Watthmann no. 41. Lastly we obtained stock solution of which we made dilutions. To calculate the MIC (minimum inhibitory concentration), we used sets of sterile plastic plates, disposable, containing 96 wells, spread over 12 rows, flat bottom and a capacity of approximately 300 ml. As a medium for growth of the bacterial suspension, we used BHI medium.

The chemical characterization Hydroethanolic extracts was performed using thin layer chromatography. Thin-layer chromatography (TLC) and high performance (HPTLC) is a

distribution process in several stages. This process includes: an adsorbent (stationary phase), a solvent or mixture of solvents (mobile phase or eluent) and the sample molecules.

As support for the thin layer, we used an aluminum absorbent foil (20 × 10 cm) covered with silica gel 60F254 HPTLC into strips 8 mm to 1,5 cm from the lower edge of the plate at a rate of 80 nL / s, using a semi-automatic applicator device (Linom 5 – CAMagic, Muttentz, Switzerland).

The fingerprints detected at different wavelengths obtained after development, have allowed the observation of various features for complete information.

Results and discussion

The spectrum of virulence strains studied

The resistance factors for the spectral analysis of the 10 strains analyzed (4 strains of *Bacillus subtilis* 3 strains of *Bacillus pumilus* and 3 *Pseudomonas syringae* strains) revealed the presence of external enzymes and proteases pore-forming. Gelatinase activity of matrix metalloprotease present, giving strains producing capacity of invasion and dissemination in the wood structure.

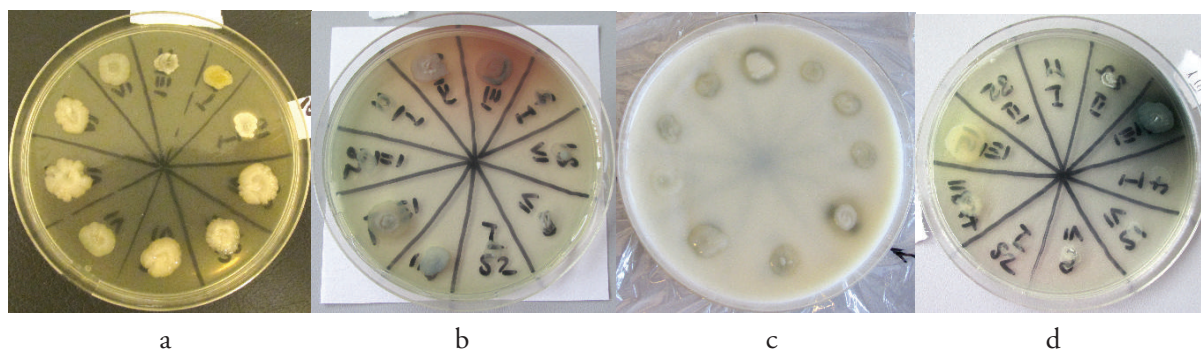


Fig. 1: Detection of the external enzymes: gelatinase (a), caseinase (b) DN-ase (c) and lecitinase (d)

MICs read at an absorbance of 620 nm was calculated as the lowest concentration which inhibits by 50% the increase of CFU (compared to the positive control of well 11). In the positive control was made sowing of bacterial suspension without added plant extract.

Table 2: Absorbance value of UFC corresponding hydroethanolic concentration of *Juglans nigra* extract observed at spectrophotometer reading at 620 nm.

	UFC (observed at 620 nm)								
Concentr of <i>J. nigra</i>	<i>Bacillus subtilis</i> 2 III.	<i>Bacillus subtilis</i> 4 I.	<i>Bacillus subtilis</i> 25 II.	<i>Bacillus subtilis</i> 29 II.	<i>Bacillus pumilus</i> 3 II.	<i>Bacillus pumilus</i> 16 I.	<i>Pseudomonas syringae</i> 11 III.	<i>Pseudomonas syringae</i> 8 II.	<i>Pseudomonas syringae</i> 21 III.
500 mg/ml	0.121	0.098	0.078	0.179	0.107	0.096	0.087	0.064	0.094
250 mg/ml	0.098	0.064	0.069	0.095	0.086	0.056	0.067	0.057	0.059
125 mg/ml	0.056	0.081	0.076	0.049	0.076	0.051	0.121	0.051	0.063
62.5 mg/ml	0.080	0.084	0.095	0.058	0.083	0.068	0.149	0.089	0.096
31.25 mg/ml	0.098	0.107	0.099	0.078	0.095	0.097	0.198	0.129	0.131
15.625 mg/ml	0.168	0.178	0.207	0.097	0.167	0.174	0.209	0.183	0.159
7.831 mg/ml	0.121	0.108	0.078	0.259	0.271	0.169	0.328	0.478	0.149
3.90 mg/ml	0.253	0.476	0.498	0.287	0.296	0.375	0.427	0.309	0.375

1.953 mg/ml	0.392	0.497	0.652	0.318	0.379	0.399	0.357	0.391	0.401
0.976 mg/ml	0.409	0.597	0.714	0.375	0.487	0.439	0.524	0.549	0.523
M ⁺ (without extract)	0.599	0.579	0.609	0.578	0.586	0.594	0.593	0.592	0.592
M ⁻ (without bacterial inoculum)	0.048	0.046	0.046	0.048	0.047	0.045	0.048	0.045	0.048

MCI of the hydroethanolic extract of *J. nigra* had values between 15,625 µg / mL and 250 µg /mL.

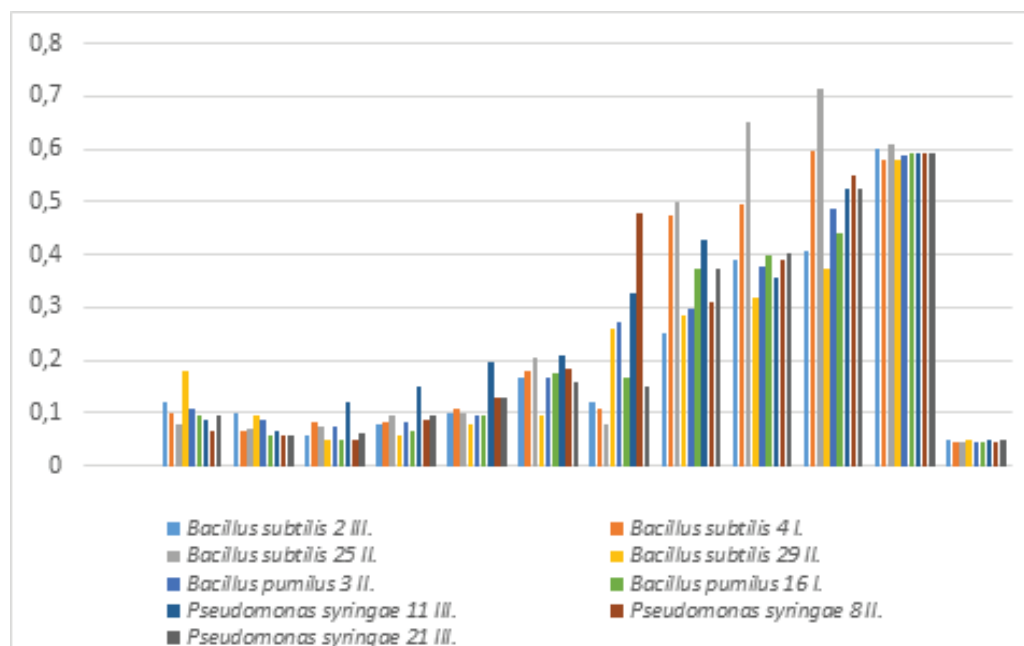


Fig. 2: Effect of *Juglans nigra* hydroethanolic extract against phytopathogenic bacteria.

Separation of the secondary compounds of *J. nigra* extract with antibacterial activity by thin-layer chromatography (TLC)

Chromatographic fingerprints read at different wavelengths revealed the existence in the composition of the *J. nigra* extracts of compounds with antibacterial activity. The best resolution was obtained at an absorbance of 400 nm.

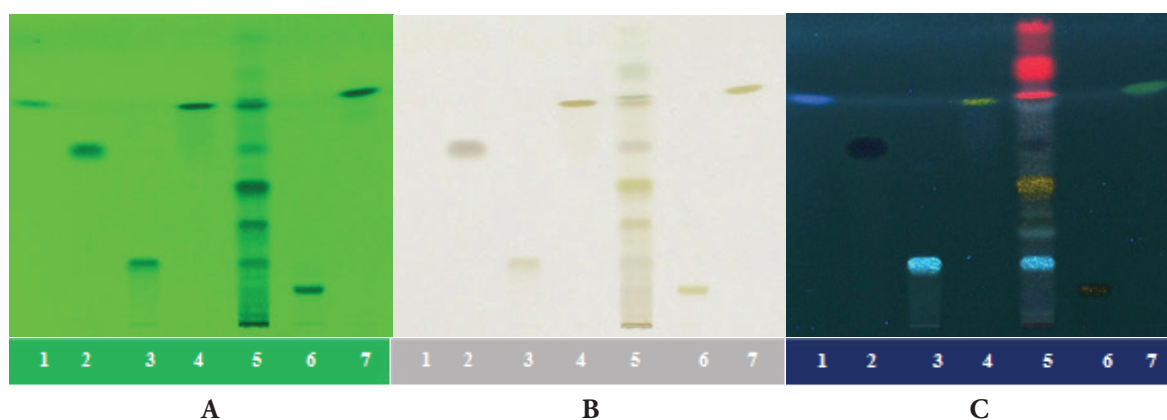


Fig. 2 Chromatographic Fingerprints of *Juglans nigra* hydroethanolic extract: (A) detection at 254 nm, (B) visible light detection and (C) detection at 400 nm. The sequencing of standard plates and extract compounds: 1 – ferulic acid, gallic acid 2, 3 – chlorogenic acid, quercetin 4-, 5- plant extract, rutin 6, 7 – kaempferol

Conclusions

Hydroethanolic extract of *Juglans nigra*, had a very good activity against phytopathogens Gram positive and Gram negative strains. Although phytopathogens are specific of plants, however they may have harmful effects on the human body. The mode of action of phytopathogens remain an area of study, too little is known of their mechanisms of action that may have repercussions on the human body, with reference, especially to persons who from different reasons, due to their field activity, are in permanent contact with wooden objects which are subject to bacterial attack. The importance of finding herbal extracts with wide spectrum antibacterial activity is reflected by the ease of obtaining them but especially by specific action against pathogenic microorganisms which proved to be not infrequently severely, most often with irreversible implications.

The antibacterial activity of the hydroethanolic extract of *J. nigra* was due to role of metabolic synthesized compounds which acts in concert against pathogens bacteria. As a general conclusion, hydroethanolic extracts of *J. nigra*, can be successfully used both to prevent bacterial attack and for its invasion.

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**ACTIVITATEA ANTIBACTERIANĂ A COMPUȘILOR DERIVAȚI DIN
EXTRACTUL HIDROETANOLIC DIN *JUGLANS NIGRA*
(Rezumat)**

Obiectele din lemn cu valoare de patrimoniu, atât cele expuse la condițiile de mediu extern, cât și cele din spațiile închise sunt adesea expuse atât atacului fungic, cât și bacterian. Degradarea apare, de cele mai multe ori, în timp, fără urme vizibile în exterior, dar cu efect ireversibil. De obicei, bacteriile care atacă lemnul nu au acțiune și asupra organismului uman. Cu toate acestea, au fost raportate câteva cazuri de pacienți cu infecții produse de bacterii fitopatogene. Scopul lucrării a fost acela de a testa compușii activi obținuți din extractul hidroetanolic din *Juglans nigra* împotriva unor fitopatogeni cu acțiune și asupra organismului uman. Compușii activi cu acțiune antibacteriană au fost identificați și separați prin metoda de cromatografie pe strat subțire. În urma analizei cantitative, a rezultat că extracul hidroetanolic din *J. nigra* a avut efect antibacterian cu o concentrație cuprinsă între 250 și 31.125 mg/mL. În concluzie, am putea spune că aceste extracte pot fi folosite cu succes împotriva bacteriilor patogene.

CONSIDERATIONS REGARDING THE CONSERVATION STATUS OF 40A0* SUBCONTINENTAL PERI-PANNONIC SCRUB IN GRĂDIȘTEA MUNCELULUI CIOCLOVINA NATURAL PARK

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Abstract: In this paper is presented a priority habitat (40A0* Subcontinental peri-Pannonic scrub) that can be found in Grădiștea Muncelului Cioclovina Natural Park. This natural habitat has a favorable status of conservation in the entire area from the park, its phytocoenoses being mentioned since 1974 (Boșcaiu et Peterfi) from Crivadia Gorges.

Keywords: habitat, conservation, Grădiștea Muncelului Cioclovina Natural Park

Introduction

The coenoses of this habitat are characteristic to the Pannonian bioregion and immediately adjacent areas (Central and South-eastern Europa). There are saxicolous, xero-mesophilous, thermophilous and calcicolous coenoses that sheltered endemic, rare and endangered species. Gafta et Mountford (2008) mentions some plant associations characteristic to this habitat that are founded in our country, as follows: *Calamagrostio-Spiraeetum ulmifoliae* Resmeriță et Csűrös 1966; *Spiraeetum crenatae* Morariu et Ularu 1981; *Syringo-Genistetum radiatae* Maloș 1972; *Asplenio-Syringetum vulgaris* Jakucs et Vida 1959; *Carici humilis-Sorbetum dacicae* Gergely 1962; *Corno-Fraxinetum orni* Pop et Hodișan 1964; *Syringo-Fraxinetum orni* Borza 1958 em. Resmeriță 1972; *Prunetum tenellae* Soó 1947; *Prunetum fruticosae* Dziubaltowski 1926; *Syringo-Carpinetum orientalis* Jakucs 1959; *Alno incanae-Syringetum josikaeae* (Borza 1965) Rațiu et al. 1984; *Evonymo-Prunetum spinosae* (Hueck 1931) Tx. 1952 em. Pass. et Hoffm. 1968.

Material and methods

The assessment of the conservation status for 40A0* habitat was realized based on the phytosociological surveys in 2015 by trained personnel of the Park Administration. Also some data were taken from the management plan made by a scientific team of the project “*Integrated management plan revision Grădiștea Muncelului Cioclovina Natural Park ROSCI0087 and ROSPA0045, cod SMIS-CNSR 4749*”.

Results and discussions

Correspondence:

EMERALD: 31.8B South-eastern deciduous thickets;

CORINE: 31.8B3 Greek sub-Mediterranean deciduous thickets; 31.8B South-eastern sub-Mediterranean deciduous thickets

PAL.HAB: 31.8B322 Danubian lilac thickets; 31.8B3222 Lilac manna ash thickets

EUNIS: F3.2432 Moesian lilac thickets; F3.2431 Moesian oriental hornbeam thickets

Romanian classification system: R3124 South-eastern Carpathian scrub of lilac (*Syringa vulgaris*) and *Asplenium ruta-muraria*, R3127 South-eastern Carpathian scrub of lilac (*Syringa vulgaris*) and manna ash (*Fraxinus ornus*)

Site description

The habitat 40A0* occupies approximately 476 hectares in the area of Grădiștea Muncelului Cioclovina Natural Park, being identified in Tecuri, Crivadia Gorges, Fundătura Ponorului-Cioclovina. The characteristic phytocoenosis of this habitat belong to the association *Asplenio-Syringetum vulgaris* Jakucs et Vida 1959.

In terms of altitude, this habitat is distributed mostly between 800–1200 m. The inclination of slopes is generally moderate to high, with most values ranging between 10–30 degrees. The habitat occurs in 64% on sunny slopes (South, South-West), on calcareous rocks and relatively large slope, which favored the development of a xerothermophilous vegetation. In terms of climate, habitat 40A0* is characterized by average annual temperatures between 7,5 °C and 8,5 °C, and average annual precipitation between 730–780 mm.

The geological substrate is dominated by limestone and conglomerates and yellowish-white micro-conglomerates. The characteristic soils are superficial rendzinas.

Community structure:

The arborescent and scrub layer is edified by *Fraxinus ornus* (coverage of 50%) and *Syringa vulgaris* (coverage of 25%), being with which were identified *Cornus mas*, *Rhamnus saxatilis* ssp. *tinctorius*, *Sorbus borbasii*, *S. dacica*, *Clematis vitalba*, *Ligustrum vulgare*, *Tilia cordata*, *Corylus avellana*, *Crataegus monogyna*, *Acer campestre*, *Euonymus verrucosus*, *Prunus avium*. The herbaceous layer is very diversified, the most frequently species are: *Teucrium chamaedrys*, *T. montanum*, *Aster amellus*, *Galium album*, *Cynanchum vincetoxicum*, *Thymus comosus*, *Asperula cynanchica*, *Genista radiata*, *Cytisus leucotrichus*, *Pimpinella saxifraga*, *Helianthemum nummularium*, *Dictamnus albus*, *Sedum maximum*, *S. hispanicum*, *Seseli libanotis*, *Hepatica transsilvanica*, *Asplenium ruta-muraria*, *A. trichomanes*, *Cystopteris fragilis*, *Piptatherum virescens*, *Cardaminopsis arenosa*, *Sesleria rigida*, *Erysimum odoratum*, *Doronicum columnae*, *Campanula rapunculoides*, *C. glomerata*, *Leontodon asper*, *Saxifraga cuneifolia*, *Dianthus spiculifolius*.

It is a habitat with high conservation value that shelters rare, vulnerable and endemic species listed in the Red List of superior plants from Romania [5], such as: *Sorbus borbasii*, *S. dacica*, *Thymus comosus*, *Hepatica transsilvanica*, *Piptatherum virescens*, *Dianthus spiculifolius*, *Dictamnus albus*.

Conclusions

Due to its development installation on steep slopes, this type of habitat is not currently subject of threats and/or pressures. A possible threat to the habitat structure is the subsponaneous species *Ailanthus altissima* and *Robinia pseudacacia*.

Among the conservation measures we mention: removing the alien vegetation in the juvenile stage; access control of animals for grazing near the habitat and restricting / prohibiting the collection of ornamental species from spontaneous flora-*Syringa vulgaris*.

Acknowledgement

We are very grateful to the research team from the project *Integrated management plan revision Grădiștea Muncelului Cioclovina Natural Park ROSCI0087 și ROSPA0045*, code *SMIS-CNSR 4749* that gives us new data from the field.

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CONSIDERAȚII ASUPRA STĂRII DE CONSERVARE A HABITATULUI 40A0* TUFĂRIȘURI PERI-PANONICE, ÎN PARCUL NATURAL GRĂDIȘTEA MUNCELULUI CIOCLOVINA (Rezumat)

Parcul Natural Grădiștea Muncelului Cioclovina este situat în Munții Șureanu, ocupând o suprafață de 38184 ha. Scopul creării parcului natural este protecția și conservarea unor ansambluri peisagistice în care interacțiunea activităților umane cu natura de-a lungul timpului a creat o zonă distinctă, cu valoare semnificativă peisagistică și culturală, cu o mare diversitate biologică. Parcul Natural Grădiștea Muncelului-Cioclovina are o însemnată valoare floristică, datorită florei bogate. Pentru evaluarea stării de conservare a habitatului prioritar 40A0* identificat în Fundătura Ponorului-Cioclovina, Tecuri, Crivadia au fost efectuate relevee fitosociologice în teren. În lucrare au fost utilizate rezultatele, referitoare la acest habitat, obținute de echipa de biologi, implicați în implementarea proiectului „*Revizuirea Planului de Management integrat pentru Parcul Natural Grădiștea Muncelului Cioclovina ROSCI0087 și ROSPA0045, cod SMIS-CNSR 4749*”. S-au identificat următoarele specii frecvente în compoziție: *Asplenium trichomanes*, *Cystopteris fragilis*, *Piptatherum virescens*, *Cynanchum vincetoxicum*, *Dianthus petraeus*, *Sesleria rigida*, *Thymus comosus*, *Campanula rapunculoides*, *Asplenium viride*, *Cornus mas*, *Rhamnus cathartica*, *Euonymus verrucosus*, *Cardaminopsis arenosa*, *Seseli libanotis*, *Aconitum anthora*, *Dictamnus albus*, *Doronicum columnae*, *Hepatica transilvanica*, *Campanula glomerata*, *Teucrium montanum*, *Saxifraga cuneifolia*, *Mycelis muralis*, *Sedum maximum*, *Ligustrum vulgare*, *Erysimum odoratum*, *Selaginella helvetica*.. Cenozele cu liliac din Fundătura Ponorului, Tecuri, Crivadia aparțin asociației *Asplenio-Syringetum vulgaris* Jakucs et Vida 1959 și sunt cantonate pe stâncăriile calcaroase, puternic însoțite. Spectrul cormoflorei este format din specii sudice, europene, eurasiatice, calcifile, mezoxerofile. Remarcăm prezența exemplarelor viguroase ale elementului dacic, endemic pentru flora României *Sorbus borbasii*. Un rol important la edificarea covorului ierbos îl au speciile diferențiale ale ordinului *Asplenetalia rutae-murariae* (*Asplenium viride*, *A. trichomanes*, *A. ruta-muraria*, *Cystopteris fragilis*, *Moehringia muscosa*). De asemenea, sunt prezente și elemente caracteristice sesleriitelor precum: *Sesleria rigida*, *Dianthus petraeus*, *Seseli libanotis*, *Aconitum anthora*, *Thymus comosus*, *Erysimum odoratum*, *Doronicum columnae*. În zonele în care a fost identificat, acest habitat se află într-o stare favorabilă de conservare, nefiind necesare măsuri speciale de management.

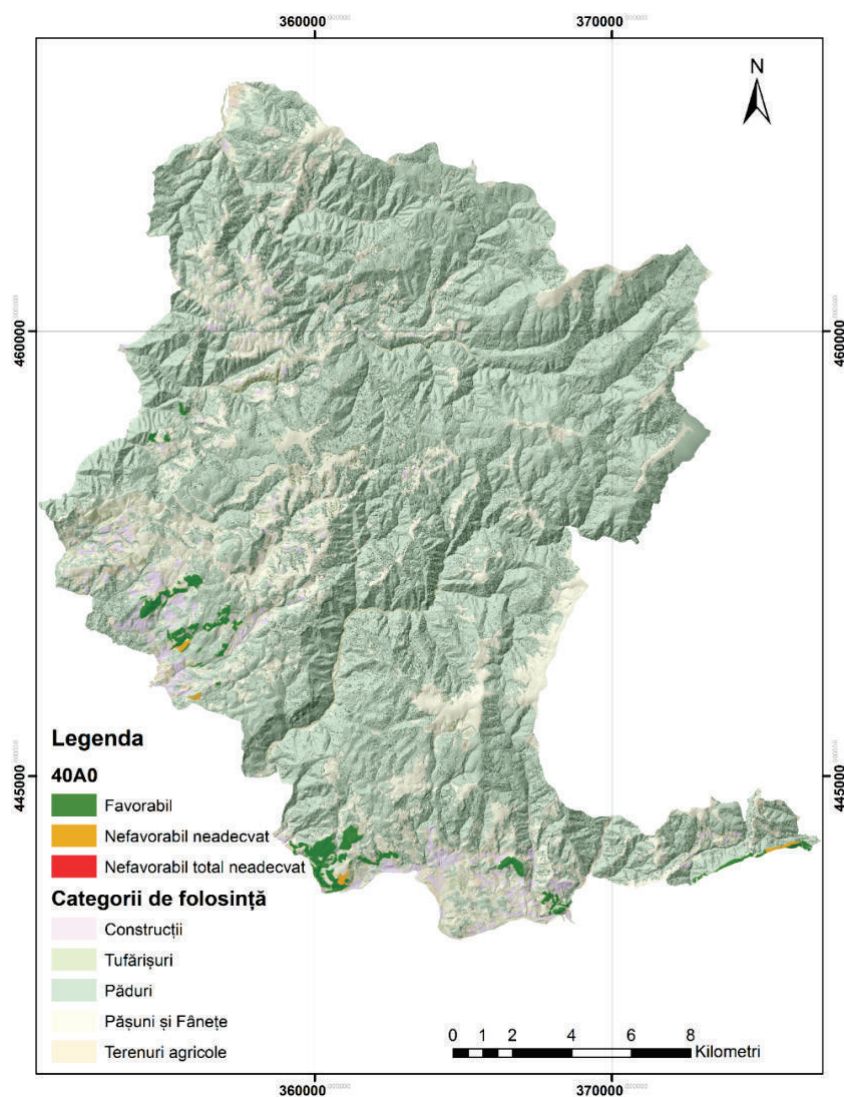


Fig. 1: Conservation status of 40A0*



Fig. 2: The habitat 40A0* Subcontinental peri-Pannonic scrub at Tecuri



Fig. 3: *Dictamnus albus*



Fig. 4: *Cornus mas*



Fig. 5: *Aster amellus*



Fig. 6: *Hepatica transsilvanica*



Fig. 7: *Teucrium chamaedrys*



Fig. 8: *Sorbus borbassii*

LIGULARIA SIBIRICA* (L.) CASS. CHOROLOGY IN ROMANIA AND EUROPE, ALONG WITH WORLDWIDE CHOROLOGY OF GENUS *LIGULARIA

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Abstract: Climate oscillations that happened during postglacial and glacial periods caused the migration of some plant species to optimum survival conditions.

This paper aims to present the distribution of *Ligularia sibirica* (L.) Cass. relict species at European and national level, as well as the worldwide *Ligularia* genus chorology using bibliographic sources and personal research in the field. The presentation of the main factors affecting the existence of *Ligularia sibirica* (L.) Cass. species in the habitats of Romania, complements this study.

Ligularia sibirica (L.) Cass. is found in habitats as: marshy grassland, meadow areas, wet soils, eutrophic and oligotrophic marshes or in peat bogs with forest vegetation.

Activities such as overgrazing and agricultural drainage works are the main reasons that can cause the extinction of this species.

Romania and Southern France assure optimal conditions for the development and conservation of *Ligularia sibirica* (L.) Cass. populations.

Keywords: *Ligularia* genus, *Ligularia sibirica* (L.) Cass., chorology.

Introduction

Ligularia genus belongs to the *Asteraceae* family, including perennial species with short rhizomes and hairless or pubescent short roots. Basal leaves are well developed, arranged in rosette, palmately or pinnately veined with a long petiole. The leaves are fewer in number, alternates on the stem, being similar to basal leaves and decrease in size starting from the base of the plant to the inflorescence. Also the petiole is short with or without sheath. Medium and large capitula are arranged in raceme. The central flowers are hermaphrodite, the radial ones are ligulate and female. Involucre is campanulate with phyllaries in one row, at the base with small and few scales. The receptacle is nude and the cylindrical achenes are with or without pappus. [26, 33]

***Ligularia sibirica* (Linnaeus) Cassini (Dict. Sci. Nat. XXVI: 402. May. 1823)**

The species is perennial with a short and thick rhizome, with long lateral roots, fleshy, fasciculated, which shows the fibrous petiole remains from the previous years. The stem is straight, vigorous, with a height till 200 cm, cylindrical, ribbed, glabrescent or coarse hairy. Basal and stem leaves have very long petioles, being deltoid-ovate or deltoid-reniforme. The medium leaves are similar to the basal ones, with short petiole. The inflorescence is erect, the blooming ones measuring 3–4 cm in diameter, with a long peduncle almost as involucre, with longer bracteole than the peduncle and pendent capitula after blooming. The achenes are glabrous, cylindrical,

up to 6 mm long; the pappus is sordid brown, slightly longer than achenes. It is usually blooming starting from July till end of August. [26] fig. 1.

Materials and methods

For the accomplishment of this work were used journals, publications, national and international specialized websites. To achieve the aim of this paper, were performed: presentation of *Ligularia* genus distribution, identification of the species number for each country and the occupied area [8], [9], [12], [15], [16], [19], [22], [23], [33], [35]; the economic importance of *Ligularia* genus [14], [36]; presentation of *Ligularia sibirica* (L.) Cass. species chorology in Asia and the occupied areas [14], [19], [22], [23], [35]; the relict distribution in Europe [7], [10], [11], [13], [14], [24], [25], [27], [32], [34]; *Ligularia sibirica* (L.) Cass. in Romania [1], [2], [3], [5], [6], [7], [17], [18], [21], [26], [28], [30], [31], [32]; legislation that protects the taxon, contributing to its preservation [3], [4], [5], [7], [17], [19], [29].

The abbreviations used in text are: AG – Argeş, BV – Braşov, CE – Critically Endangered, CJ – Cluj, CV – Covasna, DB – Dâmboviţa, DD – Data Deficient, HD – Hunedoara, HR – Harghita, IUCN – International Union of Conservation of Nature, MM – Maramureş, NT – Neamţ, PH – Prahova, SV – Suceava, VL – Vâlcea.

Results and discussion

Ligularia genus

Ligularia genus includes about 140 species spread in the temperate zones from Asia and Europe; in Europe there are two of these species: *Ligularia sibirica* (L.) Cass. and *Ligularia glauca* (L.) O. Hoffm.

The distribution of the genus *Ligularia* varies by area, being found on the river valleys, on the banks of lakes, eutrophic marshes, peatbogs, wet and swampy meadows, sometimes salted, in humid forests, at the edges of woods, forest glades, on the rocky slopes and scree in the alpine zone. The altitudes where the species can be found, varies from 100 m in Northern Asia to 4800 m in the rest of the mainland. Ecological conditions and the altitude cause an increased variability in the height of species, these measuring from 5 cm on the rocky slopes and scree from the alpine zone, reaching up to 200 cm on the valleys of the rivers, eutrophic marshes, forest understories, grasslands etc.

The species belonging to *Ligularia* genus from Asia are distributed within 22 states, listed in a descending order, from the country with the more existing species to the those with less species, as follows: China (123 sp.), Russia (38 sp.), Nepal (10 sp.), Japan and South Korea (9 sp.), India (8 sp.), Kazakhstan (7 sp.), Bhutan, Mongolia and Kirghistan (6 sp.), Tadjikistan and Pakistan (4 sp.), Myanmar, Taiwan and Uzbekistan (3 sp.), Afghanistan and Vietnam (2 sp.), Armenia, Azerbaijan, Georgia, Iran, Turcia (1 sp.).

China is the country with the most species of the genus *Ligularia*, from the 123 species, 89 are endemic. They occupy sites in wetlands like riverbanks and lakes; grassy areas from eutrophic marshes, swamp grasslands and meadows on shaded slopes; peatbogs; forest areas: in mixed forests, forest understories, valleys and rocky areas and also at the edges of forests, scrubland. The habitats where the species are growing reach the alpine area, in arid places on the scree of high Hengduan Mountains or alpine meadows such as those from Tibet.

Russia covers across its territory 38 species of *Ligularia* genus. Often they occupy similar habitats as the ones from China.

Many species of *Ligularia* genus have a high economic importance due to its habitus, being often used as ornamental plants. The seeds and sometimes the rhizomes from species as *Ligularia dentata* which is grown in Europa, *Ligularia japonica* grown in North America, along with other species, can be purchased from various websites on most countries.

Another use for the species of *Ligularia* genus: *L. sagitta*, *L. fischeri*, *L. veitchiana*, *L. lapathifolia*, *L. sibirica* and *L. hodgsoni*, can be found in traditional medicine. It can be used in treating or alleviating a variety of ailments such as cough, flu, tuberculosis, asthma, also improves blood circulation, relieves pain, relieves arthritis, etc.

***Ligularia sibirica* (L.) Cass. in Asia**

Ligularia sibirica (L.) Cass is located on the Asian continent up to 2500 m altitude in marshes, humid places, riverbanks; the species high varies between 20 and 200 cm depending on the site. The species is widespread in numerous areas: grasslands, eutrophic marshes, scrubs along rivers, scrubs of *Alnus glutinosa*, shady places, forests understories, riverbanks, transition mires from large valleys and in taiga forests.

In Asia the *Ligularia sibirica* (L.) Cass. species is spread over eight countries, with the most resorts in Russia, followed by China, Mongolia, Turkey, Armenia, Azerbaijan, Georgia and Kazakhstan.

On the Russian territory *Ligularia sibirica* (L.) Cass. can be found in areas such as grasslands, eutrophic marshes, shrubs along river courses, alder bushes from: Altai, Buriatia, Chita, Irkutsk, Kemerovo, Krasnoïarsk, Kurgan, Novosibirsk, Omsk, Tomsk, Tuva, Tiumen, Yakutia-Sakha, Habarovsk, Magadan. [14]

In China, the species occupies habitats in the Northeast of the country in Heilongjiang, Jilin, as eutrophic marshes and transition mires, moist shady places, riverbanks. [16], [35]

Mongolia has *Ligularia sibirica* (L.) Cass. in shady places from transition mires, located in the large valleys of taiga forest area from the Khentey Mountains, the average altitude being of 600–800 m. [20]

In Dağköy Valley from Turkey, the species is found in wet meadows sites at an altitude of 2500 m. [22]

***Ligularia sibirica* (L.) Cass. in Europe**

In glacial and interglacial periods there has been a migration of a large number of species, thereby in Preboreal *Ligularia sibirica* (L.) Cass. has arrived in Europe. Currently, the species is considered glacial relict, because has stand the glacial periods by maintaing or changing the occupation area from Asia to Western Europe.

On the European continent the *Ligularia sibirica* (L.) Cass. relict is distributed throughout 11 countries: Russia, Estonia, Latvia, Poland, Slovakia, Croatia, Austria, Romania, Bulgaria, France and Ukraine.

Bulgaria hosts *Ligularia sibirica* (L.) Cass. in alpine bioregions of Natura 2000 sites: Krush, Izvor.

In the **Czech Republic** we meet the community interest species in the continental bioregions from Natura 2000 sites: Niva Bele u Klokocky, Jestrebsko – Dokesko, Boletice, and Reckov.

Slovakia hosts the glacial relict in the alpine bioregions from the following Natura 2000 sites: Nízke Tatry, Slovenský raj, Kráľovoľské Tatry, Salvátorské lúky, Belianske lúky.

In **Ukraine** the species can be found in: Chornohora Mountains, Volyn' Region, Lviv, Rivne, Tenopil, Roztochchya, and Khmelnytskyi Region. The species has a good conservation status in Choronhora Mountains and a critically endangered status in the rest of the regions.

France has 11 Natura 2000 sites where *Ligularia sibirica* (L.) Cass. is protected in the continental, alpine and mediterranean bioregions: Forested environments of the Châtillon area

with tufaceous marshland and sites with the Lady's slipper orchid, Central plateau of Aubrac Aveyron, Loire and its tributaries, Artense, Cézallier, Cantal Massif, Mezenc, Aubrac Plateau, The Puys Chain, Capcir, Carlit and Campcardos, Madres-Coronat Massif.

Austria has a single Natura 2000 site that includes glacial relicts *Ligularia sibirica* (L.) Cass., which has its area in alpine bioregions: Nordöstliche Randalpen, Hohe Wand – Schneeberg – Rax.

Estonia protects the relict species in boreal bioregions from Natura 2000 sites as follows Haanja, Tagula, Sootaga, Edise, Väägvere, Öisu, Anne.

On the **Croatia** territory, *Ligularia sibirica* (L.) Cass. is spread in the alpine bioregion in Natura 2000 site, Plitvice Lakes National Park.

In **Poland**, the continental and the alpine bioregions host *Ligularia sibirica* (L.) Cass. species in Natura 2000 sites: Ostoja Szaniecko-Solecka, Suchy Młyn, Pakosław, Polana Biały Potok, Torfowisko Sobowice, Torfowiska Chełmskie.

On the territory of **Latvia**, the relict species risks the extinction, so the Natura 2000 sites that include the species are found in boreal bioregions: Krustkalnu dabas rezervats, Zusu-Stainu avoti.

***Ligularia sibirica* (L.) Cass. in Romania**

Kitaibel is the first naturalist who mentions the *Ligularia sibirica* (L.) Cass. relict in 1796 in Romania, in Taul lui Dumitru swamp. In our country the presence of this taxon from Tardiglacial period till nowadays has been demonstrated through the Würmiene age determination of the eutrophic marsh from Natural Reserve Fanetele Seculare Ponoare.

Ligularia sibirica (L.) Cass. is considered a hemicyptophyte, Boreal-Eurasian, mesohygrophilic, microtherm, acid-neutrophilous and polyploid species. The taxon grows at altitudes between 407 m in Bosanci (Suceava) and 2100 m in Caraiman (Bucegi), as well as on the territory of 11 counties.

In Romania, *Ligularia sibirica* (L.) Cass. relict follows the wetlands from sites such as: meadows with water at the surface, eutrophic marshes, peatbogs, marshy meadows, wet woods, tall-herb sites, along the river valleys of the mountain and from subalpine level. The relict occupies limited areas in 32 Natura 2000 sites, with a large percentage in Eastern and Southern Carpathians. This taxon of community importance is growing on organic soils, eutrophic or oligotrophic peat, podzols, alluvial soils, from upper mountain level to lower alpine level.

The 32 Natura 2000 sites of community importance that protect the *Ligularia sibirica* (L.) Cass. species in Romania, are located in the continental and alpine bioregions, where there are found some of the most optimal conservation conditions across Europe. In our country, *Ligularia sibirica* (L.) Cass. is located in four habitats: 7140 Transition mires and quarking bogs, 7230 Alkaline fens, 6430 Hydrophilous tall herb fringe communities of plain and of the montane to alpine levels, 3220 Alpine rivers and the herbaceous vegetation along their banks.

Natura 2000 sites declared in 2007 and 2011 for Romania, for the conservation of the relict species, are distributed in alpine and continental bioregions. The most sites are located in alpine bioregions such as: Bazinul Ciucului de Jos (HR), Borzont (HR), Bucegi (PH, DB, BV), Călimani Gurghiu (HR, MS, BN, SV), Ciomad-Balványos (CV, HR), Ciucaș (PH, BV), Cozia (VL), Găina-Lucina (SV), Gutâi – Creasta Cocosului (MM), Harghita Mădăraș (HR), Igriș (MM), Mlaștina după Luncă (HR), Ciuc Mountains (HR, BC, NT), Maramures Mountains (MM, SV), Rodnei Mountains (BN, MM, SV), Obcinele Bucovinei (Bucovina's Ridges) Mountains (SV) 2011, Postăvaru Mountain (BV), Retezat Mountains (GI, HD, CS), Apa Lină-Honcsok Peat Bog (CV, HR), Apa Roșie Peat Bog (CV), Românești Peat Bog (SV), Ruginosu Zargon Peat Bog (CV), Natural Reserve Tinovul Mare Poiana Stampei (BN, SV),

Mohoş Peat Bog – Sfânta Ana Lake (CV, HR), Şarul Dornei Peat Bog (SV) and Luci Peat Bog (HR). In continental bioregions are the next Natura 2000 sites: Forest and eutrophic marshes Prejmer (BV), Massif Piatra Craiului (AG, BV), Castle Hill-Lempes – Hărman Marsh (BV), Fânețele seculare Ponoare (SV), Buila – Vânturarița Mountains (VL) and Făgetul Clujului – Valea Morii (CJ).

In Arges county, *Ligularia sibirica* (L.) Cass. it is found in the Southern point of Romania in Brusturet Gorges, where is in danger of extinction due to human activities such as grazing, camping in the vicinity of the site and leaving garbage in the protected area.



Fig. 1: *Ligularia sibirica* (L.) Cass. – Harman Marsh

***Ligularia sibirica* (L.) Cass. – Conservation measures**

In Europe the main causes that can lead to the extinction of the species of community interest are agricultural draining works in excess and uncontrolled grazing, along with a less influential factor as global warming.

At European level, the conservation of this taxon is reglemented by the Habitats Directive 92/43 / EEC of May 1992 Annexes IIb and IVb, and the Berne Convention by Annex I, strictly

protected species of flora, GEO 57/2007 (Law 49/2011): Annexes 3, 4 A. Most of the areas occupied by *Ligularia sibirica* (L.) Cass. (ROSCI1758) are located in 71 Natura 2000 sites, which gives the species a high protection level.

Romania, Southern France Mountains and Ukrainian Chornohora Mountains provide optimal conditions for population development and conservation of the *Ligularia sibirica* (L.) Cass. species, followed by the next countries: Estonia, Poland, Slovakia, Austria, Croatia, Czech Republic and the rest of France with an inadequate level of conservation. In Latvia, Bulgaria and the rest of Ukraine are chances for the relict to be extinct at regional level.

According to the *Carpathian List of Endangered Species*, *Ligularia sibirica* (L.) Cass. is classified as CE category and IUCN frames the taxon in DD category.

Ligularia sibirica (L.) Cass. can be used in medical treatment to cure cough, asthma and bronchitis.

Conclusions

Ligularia genus includes many species adapted to different environmental conditions in various areas as humid or arid in the temperate zones of Asia and Europe. Globally, species belonging to the genus *Ligularia* occupy sites in 33 countries.

The *Ligularia sibirica* (L.) Cass. species is characteristic for wet habitats in Europe and Asia, where is found in alpine, continental, mediterranean and boreal bioregions. Most sites of this relict species are located in alpine and continental bioregions. In boreal bioregions from Estonia and Latvia the relict species is in real danger of extinction.

Currently, in Romania *Ligularia sibirica* (L.) Cass. it is in the best conservation conditions especially in eutrophic wetlands, while in the Brustureț Gorges from Argeș county the species risks to become extinct, unless if there will be taken the adequate measures of protection.

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STUDIUL COROLOGIC AL SPECIEI *LIGULARIA SIBIRICA* (L.) CASS. ÎN ROMANIA ȘI ÎN EUROPA, RESPECTIV COROLOGIA GENULUI *LIGULARIA* LA NIVEL MONDIAL
(Rezumat)

Oscilațiile climatice din timpul glaciațiunilor și a perioadelor postglaciare au determinat migrarea unor specii de plante către condiții optime de supraviețuire.

Prezenta lucrare își propune să prezinte distribuția speciei relict *Ligularia sibirica* (L.) Cass. la nivel european și național, precum și corologia genului *Ligularia* la nivel mondial, utilizând surse bibliografice și cercetări personale de teren. Prezentarea principalilor factori care afectează existența speciei *Ligularia sibirica* (L.) Cass. în habitatele din România completează acest studiu.

Ligularia sibirica (L.) Cass. este întâlnită în habitate precum: pajiști mlăștinoase, zone de luncă, soluri umede sau în mlaștini eutrofe și oligotrofe și turbării cu vegetație forestieră.

Activitățile precum pășunatul intensiv și lucrările de drenare pentru agricultură sunt cauzele principale care pot determina dispariția speciei.

România și sudul Franței oferă condițiile optime pentru dezvoltarea populațiilor și conservarea speciei *Ligularia sibirica* (L.) Cass.

ZOOLOGY

THE GROWTH OF HALOPHILIC MICROORGANISMS IN THE PRESENCE OF WASTE GLYCEROL AND ITS CONVERSION IN GLYCIDOL AND GLYCEROL CARBONATE

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Abstract: Waste glycerol representing most important secondary product resulted in the biodiesel industry and rising environmental problems with storage. A lot of researches were conducted in order to transform this glycerol in value added products. In this work were identified several halophilic microorganisms which harbor capacity to convert waste glycerol to value added products, namely glycerol carbonate and glycidol. The tested glycerol was supplied from biodiesel production from rapeseed oil, sun flower oil, palm oil. All tested microbial strains showed capacity to grow on culture media supplemented with 1% waste glycerol. The biocatalytic activity of the cell-biomass and supernatant cultures were investigated in the conversion of waste glycerol to value-added products (glycerol carbonate and glycidol). GC-FID technique was used for the determination of the reaction products. The higher contents were detected in the supernatant of halotolerant strain 1–9 isolated from water sample in Balta Albă salt lake.

Keywords: halophilic microorganisms, waste glycerol, salt lakes, glycidol, Balta Albă

Introduction

Waste glycerol is the most important by-product in the production of biodiesel from biomass. As a direct consequence, waste glycerol (unpurified) was produced in quantities which soon will exceed current market demands leading to serious environmental problems by its storage. Taking into account these considerations in the last years several researches were conducted in order to use crude glycerol as carbon source (Sarma et al., 2013) for obtaining hydrogen (Sarma et al. 2012) or other value added products (Kumar et al., 2014). According to Global Biodiesel Market, it appears that five nations in the world, namely USA, Germany, France, Argentina and Brazil cover around 68% of total biodiesel productions (ref. 18 and 19) and the market of this product is estimated at 12.6 billion US\$ in 2014 (ref 19). The effluent resulted from the production of 100 tones of biodiesel is around 10% (10 tones) and is containing methanol, oil, soap, salts and 75% glycerol (Kumar et al., 2014; Sarma et al., 2013; Maru et al., 2012, 2013; Tan et al., 2013). Several microbial strains harbor the potential to convert glycerol by fermentation to various products. Thus, *Anaerobiospirillum succiniciproducens* converts glycerol to succinic acid (Lee et al., 2001), *Yarrowia lipolytica* to citric acid (Papanikolaou and Aggelis, 2002), *Clostridium butyricum* to butyric acid, acetic acid and 1,3-propanediol (Papanikolaou et

al., 2004) and *Klebsiella pneumoniae* shows the ability to transform glycerol in 3-hydroxypropionic acid (Wang et al., 2012; Li et al., 2013). On the other hand, *Escherichia coli* strains convert glycerol to hydrogen (Dharmadi et al., 2006; Sharninghausen et al., 2014) and other value added products like ethanol, succinic, acetic or lactic acids and fatty acids omega-3 polyunsaturated (Yang et al., 2012).

The present paper deals with the growth of moderately halophilic microorganisms isolated from saline environments in Romania on culture media supplemented with various concentrations of waste glycerol. The resulted biomass and supernatant culture were tested as biocatalyst in the biotransformation processes of waste glycerol into value-added products (e.g. glycidol and glycerol carbonate).

Materials and methods

Culture and media

The investigated halophilic microorganisms were isolated from saline lake Balta Albă, located in Romania in Buzau-Braila counties, about 170 km East of Bucharest. For the isolation of strains, one milliliter of water sample was mixed in a Petri dish with molten agar medium (MH) containing (g/l): NaCl – 100, $\text{MgCl}_2 \times 6\text{H}_2\text{O}$ – 7, $\text{MgSO}_4 \times 7\text{H}_2\text{O}$ – 9.6, $\text{CaCl}_2 \times 2\text{H}_2\text{O}$ – 0.36, KCl – 2, NaHCO_3 – 0.06, NaBr – 0.026, glucose – 1, proteose peptone – 5, yeast extract – 10 (Ventosa et al., 1989). The medium pH was adjusted to 7.0 – 7.2 before autoclaving. After solidification, the plates were incubated at 28°C for 7–10 days and after this period the colony forming units (c.f.u.) number was counted. In further experiments the culture medium were used in liquid form for growth of both wild investigated halophilic strains and *Marinococcus halophilus* strain JCM 2472 (courtesy of dr. Takashi Itoh – Japan Collection of Microorganisms).

Summary characterization of bacterial cells

The preliminary characterization of the tested strains in order to assign them to the group of moderately halophilic bacteria followed the growth in the presence of bile salts and chloramphenicol and the range of NaCl concentrations for growth. In this way, the culture media were supplemented with 0,002% chloramphenicol or 0,004% sodium deoxycholate. The strains able to grow in the presence of sodium deoxycholate and unable to grow in the presence of chloramphenicol were recorded as bacteria. In order to estimate the range of NaCl and optimum concentration of NaCl for growth, the content of NaCl from culture media was varied from zero until to 5M. The growth of the investigated strains was recorded on solidified media.

Type of waste glycerol

The ability of investigated strains to use various types of waste glycerol was tested by using culture media supplemented with 1% glycerol. The investigated types of glycerol were represented by manufacturer suppliers: Medias source, Slobozia source, sun flower oil Medias, rapeseed oil and palm oil. In some experiments the NaCl content in culture media was adjusted to 5% or 10%. The growth of the strains was recorded as optical density at 660 nm by using UV-VIS spectrophotometer (Analytik Jena).

Biotransformation of glycerol into glycerol carbonate and glycidol

The reaction mixture contained glycerol and dimethyl carbonate (1:10 molar ratio) mixed with 100 mg cell suspension or 100 µL supernatant. After 24 h (reaction time), the biocatalyst was separated from the reaction mixture by centrifugation. The liquid phase (supernatant) was dried under vacuum conditions and re-suspended in 200 µL derivatization reagent (BTFA: pyridine=1:1, v/v). GC-FID analysis was performed in order to determine the quantitative composition in glycidol and glycerol carbonate.

Results and discussions

The water sample taken from salt Lake Balta Alba which is located at the limit between the counties Buzau and Braila, in the Romanian plain at approximately 170 km East of Bucharest, is characterized by chloride content varying from 3.5 g/l (in the water sample taken after strong rain) until to 16 g/l (in the water sample taken in the absence of rain for more than three months). The soil surrounding the lake harbored around 14 g/l chloride, and the sapropelic mud from the lake 16 g/l. The pH is around 8.2–8.3. According to these data the lake could be considered a saline lake. In these samples were identified a large number of colony forming units, namely 3.5×10^5 per milliliter in water taken after rain and 2.6×10^5 in soil surrounding the lake. From these numbers, few strains were selected randomly and further investigated for their ability to use waste glycerol and summary characterized from microbiological point of view. The results showed in Table 1 revealed that selected strains are able to grow on media containing traces of sodium until to 4M NaCl. The optimum concentration of NaCl for growth in all tested strains was around 1.7–2M. The investigated strains show the ability to grow on culture media supplemented with 0.004% sodium deoxycholate but cannot grow on media containing 0.002% chloramphenicol. Catalase test was positive for four investigated strains and negative for other two (strains 1–2 and 4–2; Table 1). The color of the strains selected in this study, varied from white, cream to beige and pink (Figure 1). Excepting strain 5–1, isolated from the soil surrounding the salt lake, the remaining five have negative Gram staining. According to these preliminary data, it should be considered that the investigated strains are halotolerant (strains 1–2, 1–9, 2–1 and 5–1) or moderately halophilic (strains 3–8 and 4–2).

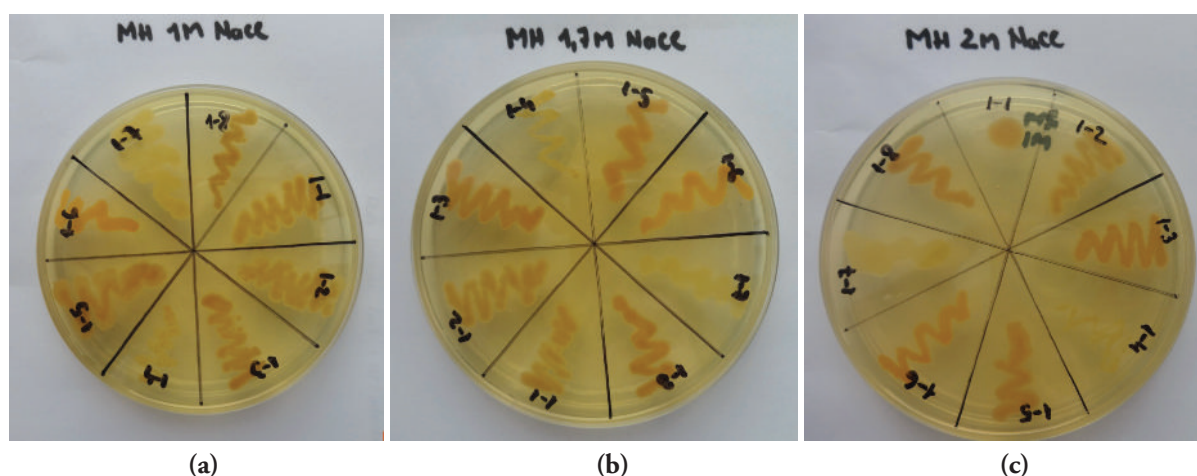


Fig. 1: Pigmentation of the investigated strains on culture media containing 1M (a), 1.7M (b) and 2M NaCl (c)

Table 1 – Summary characterization of selected bacterial strains; *0 M = sodium traces from culture media components; A = Range of NaCl (M); B = Morphology; C = Gram staining; D = Pigmentation; E = Growth on media with bile salts; F = Growth on media with chloramphenicol; G = Catalase test; + = positive answer; – = negative answer

Strain	A*	B	C	D	E	F	G
1–2	0–3	cocci	–	beige	+	–	–
1–9	0–2	cocci	–	white	+	–	+
2–1	0–3	cocci	–	beige	+	–	+
3–8	1–3	cocci	–	weak pink	+	–	+
4–2	1–3	cocci	–	beige	+	–	–
5–1	0–4	cocci	+	cream	+	–	+

In order to investigate the ability of the selected halophilic bacterial cells to use various types of waste glycerol, the culture media MH or R-Agar, in the case of the *Marinococcus halophilus* strain were supplemented with 1% tested waste glycerol. The composition of R-agar culture medium is (g/l): NaCl – 5, Peptone – 10, Casamino acids – 5, Malt extract – 5, Yeast extract – 5, Beef extract – 5, $\text{MgSO}_4 \times 7\text{H}_2\text{O}$ – 1 and Tween 80 – 50 μl . The medium pH before autoclaving was 7.2.

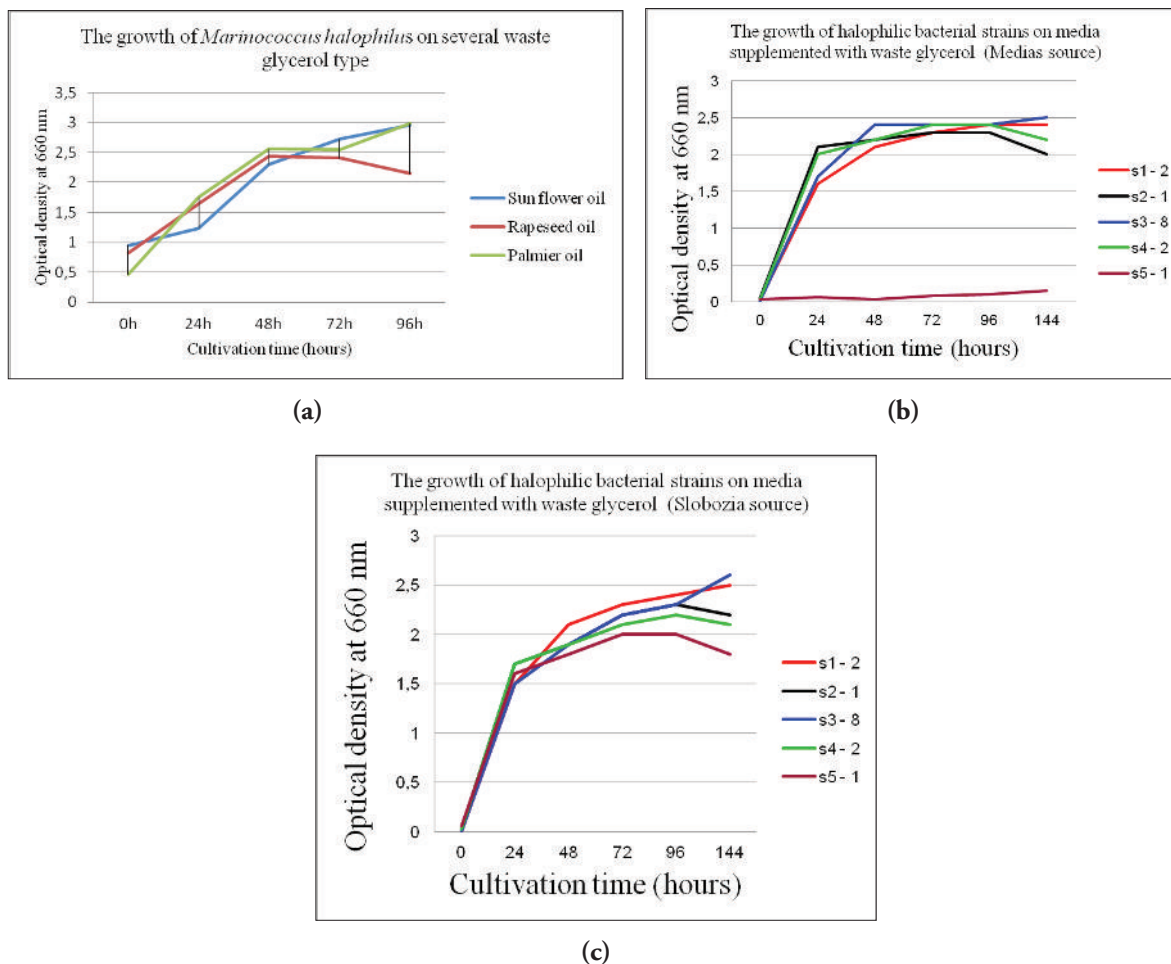


Fig. 2: The growth of the investigated strains on culture media supplemented with 1% from various types of waste glycerol

The data represented in figure 2 suggested the ability of *M. halophilus* strain to use for growth the waste glycerol resulted from biodiesel of sun flower oil, rapeseed oil and palmier oil. In the first 72 hours of cultivation (at 37°C and stirring at 150 rpm) the growth curve is similar in all investigated glycerol samples (Figure 2a). After this period the optical density decreased in case of cultivation on media supplemented with rapeseed oil. A similar behavior has been recorded in case of the investigated wild bacterial cells cultivated on media supplemented with waste glycerol from Slobozia source (Fig. 2c). According to manufacturer data these residual glycerol contains some organic matter, phosphate salts and potassium salts as a consequence of biodiesel obtaining protocols. These residual matters could be a factor for the growth behavior of the investigated strains. On the other hand, on the media supplemented with waste glycerol obtained from Medias source the strain 5–1, which showed Gram negative staining (Table 1) had no ability to grow (Figure 2b). For the other four tested strains the optical density increased for 48 hours of cultivation and after this period remained relatively constant (Figure 2b). These answers

of the strain 5–1 could be associated either to the chemical composition of cell membrane or the presence of other compounds in tested glycerol as manufacturer described. On the other hand, the putative effect of glycerol as osmoprotective agent or its effect as compatible solut (Poolman and Glaasker, 1998) should not be excluded.

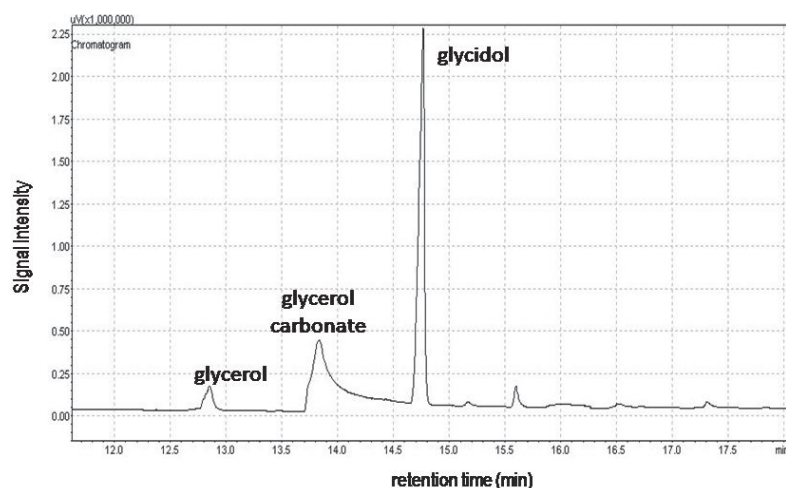


Fig. 3: GC-FID analysis of the reaction mixture pointing out the presence of glycerol carbonate and glycidol as the reaction products of glycerol biotransformation.

Table 2 – The presence of glycidol and glycerol carbonate in biomass or supernatant of *M. halophilus* and strain 1–9. The table revealed the presence of GlyD and GlyC in liquid culture after cultivation of several halophilic microbial cells; a = supernatant; b = liquid culture.

Investigated sample	Glycidol (GlyD)	Glycerol carbonate (GlyC)	Other compounds
Biomass from <i>Marinococcus halophilus</i> R-AGAR 5% NaCl	-	+	+
Biomass from strain 1–9 on MH media with 10% NaCl	-	+	-
Supernatant from <i>Marinococcus halophilus</i> R-AGAR 5% NaCl (a)	-	+	+
Supernatant from strain 1–9 on MH media with 10% NaCl (a)	+	+	-
Supernatant from <i>Marinococcus halophilus</i> R-AGAR 5% NaCl (b)	+	+	+
Supernatant from strain 1–9 on MH media with 10% NaCl (b)	+	+	+

The GC-FID investigations on biomass or supernatant resulted from cells centrifugation for 10 minutes at 9500 rpm revealed in all tested strains either the presence of glycidol and glycerol carbonate or other compounds resulted from the enzymatic conversion of waste glycerol to these chemical structures. According to the data showed in table 2 the glycidol can be produced in the presence of supernatant of the strain 1–9 cultivated in MH with 10% NaCl and supernatant of the strain *M. halophilus* cultivated in R-agar media with 5% NaCl. On the other hand the glycerol carbonate correspond to the biomass of *M. halophilus* cultivated on R-agar medium with 5% NaCl and strain 1–9 cultivated on MH media containing 10% NaCl (Table 2, Figure 3).

The results revealed the ability of the investigated halotolerant and moderately halophilic bacteria isolated from saline and hypersaline environments from Romania to convert waste glycerol in value-added products, e.g. glycerol carbonate and glycidol.

Acknowledgements

This work was supported by Program Partnerships in Priority Domains – PN II developed with the support of MEN-UEFISCDI, Project no.273/214.

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**CREȘTEREA MICROORGANISMELOR HALOFILIE ÎN PREZENȚA GLICEROLULUI
REZIDUAL ȘI CONVERSIA ACESTUIA LA GLICIDOL ȘI CARBONAT DE GLICEROL
(Rezumat)**

Glicerolul rezidual reprezintă cel mai important produs secundar rezultat din industria biodieselului, generând probleme pentru mediul înconjurător în ceea ce privește depozitarea lui. Numeroase studii au avut ca subiect încercări privind transformarea acestui glicerol rezidual în produși cu valoare adăugată. În această lucrare au fost identificate unele microorganisme halofile care au capacitatea de a transforma glicerolul rezidual în produși cu valoare adăugată, respectiv glicidol și carbonat de glicerol. Glicerolul rezidual testat a rezultat ca produs secundar la obținerea biodieselului din rapiță, floarea soarelui sau ulei de palmier. Toate microorganismele testate s-au dezvoltat pe medii de cultură suplimentate cu 1% glicerol rezidual. Conversia glicerolului rezidual la produsele cu valoare adăugată (glicidol și carbonat de glicerol) s-a observat prin determinarea activității catalitice a biomasei microbiene, precum și cea a supernatantului culturilor microbiene. În acest sens a fost utilizată metoda GC-FID pentru determinarea produșilor de reacție. Cel mai mare conținut în compușii de interes a fost identificat în supernatantul culturii bacteriene halotolerante, notată 1-9 și izolată din probă de apă provenită din lacul sărat Balta Albă.

BAT SPECIES (MAMMALIA, CHIROPTERA) HIBERNATING IN ABANDONED STONE QUARRIES FROM SAHARNA, REPUBLIC OF MOLDOVA

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Abstract: Abandoned quarries from Saharna (47°41' N, 28°57' E) situated at the 80–100 m above the sea level have several entrances. The ceiling consists of multiple cracking, remained after extraction activities and has a height of between 1.5 and 3 m. The first individuals were observed near the entrance at 2–4 m. A total of 7 km of underground passages were investigated and 325 individuals from 9 species. In 2013 we recorded only 112 individuals from 7 species, while in 2014 – 213 individuals from 9 species. During both years the dominant species was *Eptesicus serotinus* with about 65% in 2013 and only 40% in 2014, followed by *Myotis daubentonii* and *Rhinolophus hipposideros* in the first year and by *R. hipposideros* then *M. daubentonii* in the second year of study. The rest of the species were registered in low number, between 0.5% and 7%. It must be mentioned the presence of *Barbastella barbastellus* species with approximately 2% in each study period. It is a very rare, endangered species of our fauna and the Saharna site represent the only known hibernation place of this species in R. Moldova. The abandoned stone quarries from Saharna represent an important bat hibernation shelter, where hundreds of individuals spent the winter and this site need special protection.

Keywords: bats, hibernation, underground roost, Saharna, community structure

Introduction

In the Republic of Moldova the order Chiroptera comprises 21 species belonging to families Rhinolophidae and Vespertilionidae. Almost half of them hibernate in underground shelters of various origins, including abandoned stone quarries that represent important roost sites. Such roosts provide favorable conditions for mating, hibernation, rearing the young, protection from adverse weather and predators. The studies of bats hibernating in underground shelters were carried out in 60's–70's of the past century all over the republic, but mostly in the northern and central zones [2, 3, 5, 6, 7]. Then, for almost 20 years bat studies were practically abandoned and at the end of 90's they continued by several researchers mostly in the central part of Moldova and in Nistru river valley [1, 4, 13, 14]. Since 2013 intense studies on bat species hibernating in various underground shelters from the central part of Moldova have started, including preliminary results on bat communities hibernating in Saharna quarries [9, 10, 11, 12]. The abandoned stone quarries from Saharna represent an important bat hibernation site. Therefore, the bat study and monitoring in this area is of huge importance for bat conservation.

Material and methods

Abandoned stone quarries near Saharna village are located near the monastery (47°41' N, 28°57' E) at an altitude ranging between 88–100 m and there are several entries located along the slopes. The entries aren't protected in any way and the population has free access. A positive aspect for bats is that during the cold period the tourism and other recreational activities are less intense. The ceiling consists of multiple cracks left after extraction activities and has a height ranging from 1.5 to 5 m. The studies were performed in winter-beginning of the spring period of 2013–2014. The temperature outside was of -1°C–0°C in February and of 7°C–10°C in March. Inside the quarries the temperature was practically the same in both study periods: 7°C–8°C at 10 m from the entrance. The relative humidity ranged between 76% and 87%.

The bats were studied directly by visual observations, all individuals were identified. During winter the individuals weren't disturbed, while at the beginning of spring, when bats become more active, some of them were extracted from the ceiling cracks in order to determine their sex and age, weight and some morphological peculiarities.

Results and discussions

A total of 7 km of underground passages were investigated and 325 individuals from 9 species (*Rhinolophus hipposideros*, *Myotis blythi*, *M. daubentonii*, *M. dasycneme*, *M. mystacinus*, *Plecotus auritus*, *P. austriacus*, *Barbastella barbastellus*, *Eptesicus serotinus*) were registered. In 2013 we recorded only 112 individuals from 7 species, while in 2014 – 213 individuals from 9 species. This fact is probably due to the late period of study in 2013, which was at the end of March, when bats become active and begin to leave the underground shelters, while in 2014 the bat monitoring occurred at the beginning of February. In spring there were observed 12 individuals flying in the quarries.

The first individuals, belonging to *E. serotinus*, *P. austriacus* and *P. auritus* were observed near the entrance, at 3–4 m from it. The *Plecotus* species usually hibernate near the entrances of underground shelters, up to 8–10 m, while the serotine bat can be found near the entrances, as well as deeper in the underground.

Most of the individuals were found in cracks solitarily, only *E. serotinus* individuals were found in small groups, ranging from 2 to 10 individuals (fig. 1). Other species were found exclusively solitarily.



Fig. 1: *Eptesicus serotinus* found in cracks in groups of 2 and 9 individuals

During both years the dominant species was *E. serotinus* with about 65% in 2013 and only 40% in 2014, followed by *M. daubentonii* and *R. hipposideros* in the first year and by *R. hipposideros* then *M. daubentonii* in the second year of study (fig.1). In general, the ratio of species distribution is more even in February than in March, the quantitative difference between the dominant species being less pronounced in winter. The whiskered bat (*M. mystacinus*) was the fourth species after its abundance and registered 6.73% in February and 4.7% in March. The rest of the species were registered in low number, between 0.5% and 4%. The *Plecotus* genus individuals weren't registered in the first year of study, while in the February of the second year *P. austriacus* had 2,35% and *P. auritus* only 0,5%, being the least abundant bat species.

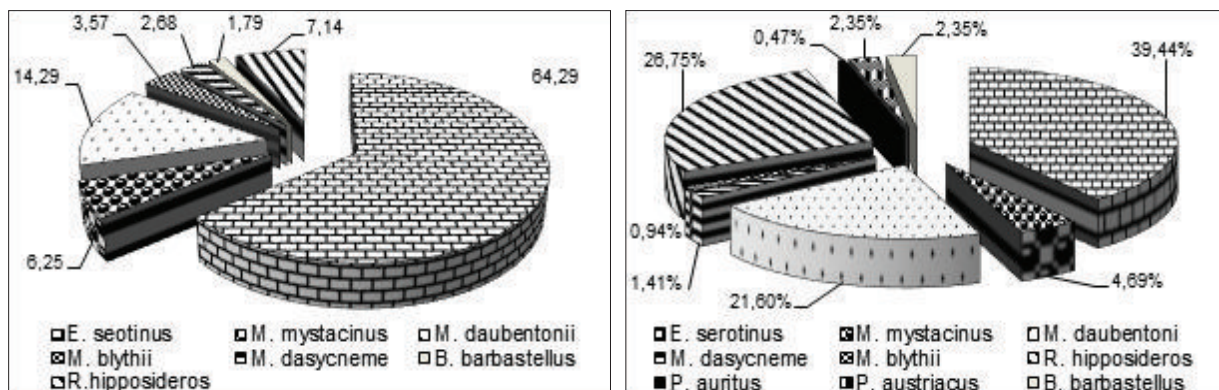


Fig. 2: Structure of hibernating bat community in abandoned stone quarries from Saharna in 2013 (left) and in 2014 (right)

It must be mentioned the presence of *B. barbastellus* species (fig. 3) with approximately 2% in each study period. It is a very rare, endangered species of our fauna and the Saharna site represent the only known hibernation place of this species in R. Moldova. Previously, the species was recorded in Cricova and Milestii Mici underground shelters [3], but at present it disappeared from these roosts [9, 10].



Fig. 3: *Barbastella barbastellus* – one of the rarest species in the fauna of Moldova

A very interesting fact was that during the studies a ringed individual of *E. serotinus* was found (ring no XC011567), adult male ringed in 1995 by one of the authors (Andreev, pers. comm.). Therefore, it was confirmed the extraordinary longevity of these small animals. The

individual was already an adult of at least 2–3 years old when it was ringed, thus in 2014 it was at least 21 years old. The maximum life span of this species is considered 21 years, but its tooth wear was not very pronounced, so we expect to find this individual in the future studies. This record also confirms that serotine bat does not migrate at long distances and is loyal to its wintering roost.

In the previous studies performed in 60–70's of the past century in Saharna quarries the quantitative and qualitative structure of hibernating bat community was different. Up to 70's of the past century the dominant species was *M. blythi*, which formed large colonies ranging from 200 to 800 individuals [5, 7]. This species represented more than 95% of hibernating bat community. Unfortunately, its number decreased constantly and toward middle of 70's the number of individuals constituted only few dozen. The whole community consisted of 4–6 species depending on the year of study. The lesser horseshoe bat was constantly recorded in the quarries, being the second species after *M. blythi* [5]. The barbastelle bat was registered only one time in Saharna quarries [5], the species being more widely distributed than nowadays [2].

In the 90's the studies on bat fauna from Saharna site continued and the community of bats in autumn period comprised 6 species [14] including *Rhinolophus ferrumequinum*, a very rare species that wasn't found in the last years. Few years later, during a 5-year monitoring, 10 bat species hibernating in Saharna underground shelters were registered, of which *Myotis nattereri* wasn't recorded in our study. The lesser horseshoe bat was dominant in during the whole year and it is still rather abundant at present, while the barbastelle bat was one of the dominant species in winter period. For the first time the species *P. austriacus* and *E. serotinus* were recorded and the highest bat diversity among all hibernation roost was mentioned for this site [13].

The abandoned stone quarries from Saharna represent an important bat hibernation roost, where hundreds of individuals from about 9 species, including rare and endangered species, spent the winter and we recommend to assign a special protection status for this site.

Conclusions

In abandoned stone quarries from Saharna during 2 years 325 individuals from 9 species were registered. In 2013 we recorded only 112 individuals from 7 species, while in 2014 – 213 individuals from 9 species.

During both years the dominant species was *E. serotinus* with about 65% in 2013 and only 40% in 2014, followed by *M. daubentonii* and *R. hipposideros* in the first year and by *R. hipposideros* then *M. daubentonii* in the second year of study. The rest of the species were registered in low number, between 0.5% and 7%.

It must be mentioned the presence of *B. barbastellus* species with approximately 2% in each study period. It is a very rare, endangered species of our fauna and the Saharna site represent the only known hibernation place of this species in R. Moldova.

The abandoned stone quarries from Saharna represent an important bat hibernation shelter, with the highest bat diversity among all hibernation roost and this site need special protection.

Acknowledgements

The work was performed under the fundamental 11.817.08.14F and applied 11.817.08.16A projects at the Institute of Zoology of A.S.M. financed by Supreme Council for Science and Technological Development of Academy of Sciences of Moldova.

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SPECIILE DE LILIECI (MAMMALIA, CHIROPTERA) CARE HIBERNEAZĂ ÎN CARIERELE ABANDONATE DE LA SAHARNA, REPUBLICA MOLDOVA (Rezumat)

Carierele abandonate de la Saharna (47°41' N, 28°57' E), situate la altitudinea de 80–100 m, au câteva intrări. Tavanul constă din multiple crăpături rămase în urma excavaţiilor şi are înălţimi cuprinse între 1,5 şi 5 m. Primii indivizi au fost observaţi în apropierea intrărilor, la 2–4 m. În total au fost parcurşi 7 km şi înregistraţi 325 indivizi din 9 specii. În 2013 au fost semnalati 112 indivizi din 7 specii, iar în 2014 – 213 indivizi din 9 specii. Pe parcursul ambilor ani de studiu, specia dominantă a fost *E. serotinus* cu cca. 65% în 2013 şi 40% în 2014, urmată de *M. daubentonii* şi *R. hipposideros*, în primul an de studiu şi de *R. hipposideros* apoi *M. daubentonii*, în al doilea an. Celelalte specii au fost semnalate într-un număr mai redus, rata acestora fiind cuprinsă între 0,5% şi 7%. Trebuie menţionată prezenţa speciei *B. barbastellus* cu circa 2% în fiecare perioadă de studiu. Este o specie periclitată şi foarte rară în fauna noastră, iar situl Saharna este unicul loc cunoscut de hibernare a speciei în R. Moldova. Carierele abandonate de la Saharna reprezintă un loc important al hibernării liliecilor, unde ierneză sute de indivizi, şi acest sit necesită statut de protecţie.

SURVEY OF COLLEMBOLA (HEXAPODA) OF THE CODRII RESERVE

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Abstract: The paper includes the study of 112 Collembolan species from diverse habitats of the Codrii Reserve. The majority of species have a large zoogeographical distribution: Palearctic (28), cosmopolitan (26 species) Holarctic and European (24 species each) and Mediterranean (7). Three species have been also cited from Poland and Ukraine or described from the Republic of Moldova. Identified Collembola species are highly diversified ecologically and in many cases habitat-restricted. List of species, distribution and some ecology are included.

Keywords: springtails, habitat, ecology, species diversity.

Introduction

Collembola (Hexapoda) is one of the most abundant and ubiquitous taxon, probably exceeding all other insects in numbers of individuals [14]. For Collembola about 8,000 species have been described in the world and the majorities of these organisms are virtually ubiquitous in terrestrial systems, being one of the more successful arthropod lineages [32].

Collembola may be sampled throughout the year in all habitats and different climatic conditions, and occupy key positions in the food webs. The representatives of this group directly participate in the formation of natural fertility and transformation of organic material. Their role in decay of plant residues and in maintaining of the natural fertility of soil is very important [24].

Knowledge of the collembolan fauna of the European reserves is far from satisfactory. Important studies were done by Bușmachiu [4]; Kaprus [16]; Nosek [19]; Rusek [22, 24]; Smolis & Skarzynski [26]; Szeptycki [28]; TRASER [30]; Weiner [31] et al. most of which are located in the mountainous areas. A lot of interesting and especially rare and unique collembolan species have been found and described from such areas.

The first result of the study of Collembola from the Codrii reserve was published in 1999 in which 65 collembolan species were cited [3]. Some data about Collembola was included in the monograph „Conspectul diversității biologice a Rezervației „Codrii” [9].

The aim of this study was to survey the collembolan species from Codrii reserve pointing to their ecological preferences. As a result of the investigations, the list of Collembola from this reserve increased to 112, which constitute about a half of the collembolan species numbered in the country [5].

Material and methods

The oldest scientific reserve in the Republic of Moldova – Codrii was founded in 1971 and is situated 50 km from Chisinau, the capital of the country. The reserve is located in the North – West of the Central Moldavian Hills between the rivers Nistru and Prut, at approximately 5 km from the locality Lozova, Strășeni district, at longitude 28° 30' E and latitude 47° 01' N. This reserve is important part of Moldavian protected areas with the surface of 5177 km² (fig.1). Vegetation of reserve consists from several types of forests, typical for European region. The rare species of plants and vertebrate animals are mentioned here, including some Carpathian elements.

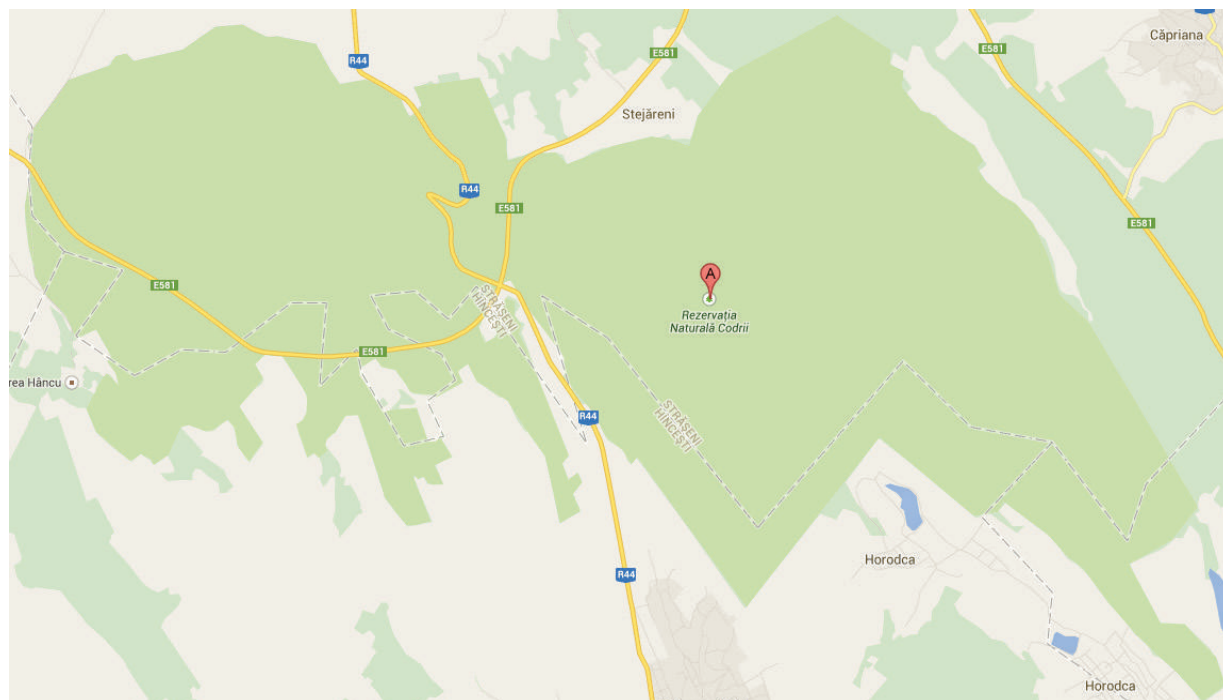


Fig. 1: Scientific Reserve Codrii

This study is the part of a long – term investigation (1994–2013 years) carried out in Codrii reserve divided into 3 functional zones: a strictly protected zone, a buffer zone, and an intermediate zone. Samples were collected in the different types of habitats of all functional zones, in the forests soil and litter, rotten trunks of oak covered by moss. The most part of the forest is mixed on the base of oak trees (*Quercus petraea* and *Quercus robur*) typical for reserve in combination with lime-ash (*Tilia tomentosa* – *Tilia cordata* – *Fraxinus excelsior*) and maple-hornbeam (*Acer campestre* – *Acer platanoides* – *Carpinus betulus*). The strictly protected zone includes also monodominant beech forest (*Fagus sylvatica*). In the buffer zone there are several types of trees plantations such as *Robinia pseudoacacia*, *Betula* sp., *Pinus nigra*, *Picea* sp., meadows and shores of lakes. Additionally, the specimens of Collembola from alfalfa crop and apple orchard situated into intermediate zone of reserve were collected for the study.

The specimens were extracted using modified flotation method [7] and fixed in 96% ethyl alcohol, sorted, cleared in lactic acid and KOH and mounted on permanent slides using Marc-Andre II solution. The specimens were identified using a phase contrast microscope LEICA 2500 equipped with camera Lucida. For identification of Collembola determination keys published within Synopses on Palaearctic Collembola [2, 10, 15, 21, 29] including some additional papers

[1, 11, 12, 20]. Morphological differences among Collembola living in different habitats was classified into life forms according to Rusek [25] and the aspects of ecological adaptations to various conditions of terrestrial ecosystems were selected from the papers [8, 11, 12, 18, 21].

The slides collection is stored in the Entomological Museum of the Institute of Zoology of Academy of Sciences of Moldova.

Photos of collembolan species included in the paper were taken with Canon EOS 60D camera at the „Muséum National d'Histoire Naturelle” Paris, France.

Results and discussions

As result of investigation 112 species of Collembola belonging to 57 genera and 15 families were found in the studied habitats of Codrîi Reserve.

The highest number of registered collembolan was from the family Entomobryidae (29 species and 7 genera), followed by the families Isotomidae (19 species and 11 genera), Neanuridae (11 species and 7 genera), Hypogastruridae (10 species and 5 genera), Onychiuridae (9 species and 5 genera), Tullbergiidae (7 species and 3 genera), Tomoceridae (5 species and 3 genera) and Katiannidae (5 species and 2 genera). Two families Sminthuridae and Dicyrtomidae were represented by 4 species (4 and 3 genera respectively), when the families Neelidae, Arrhopalitidae by 2 species and 2 genera, Odontellidae and Cyphoderidae by 2 species from one genus each. The family Sminthurididae was represented by one species and genus only.

The list of collembolan species including localities, distributions, life forms and some aspects regarding habitat preference and ecology of revealed in the Codrîi reserve species have been included in the table 1.

The plant communities are the most important soil forming factors [19], as well as the influence of soil microflora and pedobionte animals on soil structure. The attention was drawn to the collembolan communities' structure and species diversity of different habitat taken separately. As a result of investigation the collembolan species typical for the forest including litter, soil, moss, mushroom, wood decompose and open habitats as meadow and alfalfa were revealed.

In the litter of the natural forests the following species were found: *Ceratopysella engadensis*, *C. succinea*, *Schoettella ununguiculata*, *Xenylla boernerii*, *X. brevicauda*, *X. brevisimilis brevisimilis*, *Friesia mirabilis*, *Pseudachorutella assigilata*, *Pseudachorutes subcrassus*, *Deutonura albella*, *Neanura moldavica*, *Entomobrya muscorum*, *E. quinquelineata*, *Pseudosinella albida*, *P. horaki*, *P. moldavica*, *Heteromurus major*, *Lepidocyrtus lignorum*, *L. paradoxus* (photo 2b), *L. violaceus*, *Folsomia quadrioculata* and *F. penicula*.

The typical species collected under and into the wood decompose covered by moss are: *Superodontella montemaceli*, *S. lamellifera*, *Orthonychiurus rectopapillatus*, *O. stachianus*, *Onychiuroides granulatus*, *Desoria olivacea*, *Pogonognathellus flavescens*, *P. longicornis*, *Tomocerus minor*, *T. vulgaris*, *Dicyrtomina minuta* and *Neelus murinus*. Only in moss was found *Orchesella pseudobifasciata* (photo 2a).

Some soil species such as *Mesaphorura yosii*, *M. florum*, *Metaphorura affinis*, *Isotomodes productus* and *Folsomia parvulus* have been found in open habitats – meadows or alfalfa crop near the forest, while the species *Ptenothrix atra*, *Capraínea marginata*, *Lipothrix lubbocki*, *Gisiniaus flammeolus* and *Spatulosminthurus flaviceps* are considered macrophytobiont, being collected from the moss, mushrooms and open habitats.

Among the identified collembolan species found in Codrîi reserve some deserve particular attention. The species *Superodontella montemaceli* has been described from Poland (Pieniny Mt.) [1] and then found in the litter and soil of leafy forest from Ivano-Frankiv'sk, Zakarpattia and

Lviv districts in Ukraine [17]. It is a forest species that lives in the litter, under the bark of dead tree or in the moss on wood decompose. This species were recorded in several natural forests in the Republic of Moldova [4] and the specimens were collected usually near the decaying wood.

A special interest presents two species from the family Neanuridae. First of them – *Neanura moldavica* [6] has been described from the Republic of Moldova (Plaiul Fagului nature reserve). The species is recorded from many localities in Moldova, from litter, decaying wood of all kinds of silvicolous habitats (*Pinus* and *Populus* forest plantations, riparian, natural *Fagus* and *Quercus* forests) being very common in the country. The second species is *Thaumanura carolii* described by Stach in 1920 as *Achorutes carolii* from the Beskidy and Pieniny Mountains (South Poland). Later, in 1951 Stach mentioned additional localities of the species distribution from Austria, Bulgaria, Hungary, Poland, Slovakia, Ukraine and the former Yugoslavia. In our days *Thaumanura carolii* is an European species reported from the Alps, the Carpathians, the Sudetes and the Balkan Mts. [27]. In the Republic of Moldova the specimens of this species were collected from litter, rotting wood, moss and under bark of decaying logs of Codrii and Plaiul Fagului forest reserves and the natural deciduous forest near Donici village, being more abundant during the cold season, often under the snow.



Photo 2: a – *Orchesella pseudobifasciata*; b – *Lepidocyrtus paradoxus*.

Pseudosinella simpatica [13] has been described from *Acerum-Carpenetum* type of forest from Codrii Reserve, being identified also in *Robinia pseudoacacia* plantation of two other localities from the Central part of the country.

Collembola are well differentiated into ecomorphological life-forms groups. According to Rusek [25] the life-forms structure is an important parameter of Collembolan communities and reflects the state of soil development during succession and can bioindicate soil microstructure and humus form. Some life-forms are restricted to a different vertical layer of the ecosystem and therefore their functional role depends on occupying soil subhorizons. Edaphobiont group of Collembola were differentiated by Rusek [23] in euedaphobiont, hemiedaphobiont and epigeont. Euedaphic life-forms dominate in the deeper soil horizons and include the species from the families Tullbergiidae, Onychiuridae, Neelidae, Arrhopalitidae and some small, blind representatives of other families, including the species from genera *Willemia*, *Isotomodes*, *Cyphoderus* that constitute 23.2 % from the species identified in our reserve. Hemiedaphic life-forms belong to the species from genera *Pseudosinella*, *Folsomia*, *Proisotoma*, *Parisotoma*, *Tomocerus*, *Pogonognathellus* etc. that constitute 33.9% of studied species living in litter, upper soil horizon and wood decompose. Epigeont and atmobiont life-forms belong to the families Katiannidae, Dicyrtomidae, Sminthuridae and genera *Isotoma*, *Desoria*, *Lepidocyrtus* and *Orchesella* are in many cases present in moss, on bark of trees and live plants, feeding on algae, fungus hyphae,

pollen etc. Collembola of these life forms constitute 42.9% from revealed in reserve species, including macrophytobiont, microphytobiont and edaphobiont (tab. 1)

It is important to reveal the zoogeographical analysis of the studied species. In the studied scientific reserve the most abundant collembolan species have Palearctic distribution – 25%, followed by cosmopolitan – 23.2%, Holarctic and European – 21.4% each and Mediterranean – 6.3%. However, among the studied species 2.7% have a restricted area of distribution being also present in the adjacent countries Romania and Ukraine or were described from the Republic of Moldova.

The identified Collembola species are highly diversified ecologically and in many cases habitat-restricted. The presence of the rare collembolan species as well as newly described species, indicate the importance and conservation value of Codrii Reserve.

Acknowledgements

I am warmly grateful to Prof. Wanda Maria Weiner (Institute of Systematics and Evolution of Animals (Krakow, Poland) for scientific support.

The present study was performed under the project № 15.817.02.12F financed by the Academy of Sciences of Moldova.

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STUDIUL COLEMBOLELOR (HEXAPODA) DIN REZERVAȚIA CODRII (Rezumat)

Lucrarea include studiul multianual al colembolelor, soldat cu identificarea a 112 de specii colectate în diverse habitate amplasate pe teritoriul rezervației Codrii, cu predominarea speciilor cu areal de distribuție larg: paleartice (28 specii), cosmopolite (26), holarctice și europene (cu câte 24 de specii fiecare) și mediteraneene (7). Trei specii sunt cunoscute în Polonia și Ucraina sau descrise din Republica Moldova. Speciile de colembole identificate au preferințe ecologice diverse și sunt adesea depistate în microhabitate unice. Prezența speciilor rare și a celor noi pentru știință descrise de pe teritoriul Republicii Moldova indică importanța rezervației pentru păstrarea și conservarea biodiversității. Lucrarea include lista speciilor, distribuția lor și unele aspecte de ecologie.

Table 1. Collembola of the Codrîi Reserve with their habitats preferences, abundance, distribution and ecology

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
	Family Hypogastruridae		
	Genus <i>Hypogastrura</i> Bourlet, 1839		
1.	<i>Hypogastrura vernalis</i> (Carl, 1901)	Apple orchard, 2 ex., 13.10.2010.	Cosmopolitan, mesophilous, hemiedaphobiont.
2.	<i>Hypogastrura manubrialis</i> (Tullberg, 1869)	<i>Pinus</i> plantation, 3 ex., 19.05.2004.	Cosmopolitan, fungivorous, mesophilous, hemiedaphobiont.
	Genus <i>Ceratophysella</i> Börner, 1932		
3.	<i>Ceratophysella denticulata</i> (Bagnall, 1941)	Alfalfa, 3 ex., 13.10.2010.	Cosmopolitan, mesophilous, hemiedaphobiont.
4.	<i>Ceratophysella engadimensis</i> (Gisin, 1949)	Forest, litter, 3 ex., 01.06.1994.	Cosmopolitan xerophilous hemiedaphobiont.
5.	<i>Ceratophysella succinea</i> Gisin, 1949	Forest, litter, 27 ex., 21.05.1996, 5 ex., 21.08.2005; meadow, 23 ex., 19.05.2004.	Holarctic, mesophilous, compost hemiedaphobiont.
	Genus <i>Schoettella</i> Schäffer, 1896		
6.	<i>Schoettella unungiculata</i> (Tullberg, 1869)	<i>Betula</i> plantation, litter, 99 ex., 19.05.2004; meadow, 6 ex., 21.08.2005; forest, litter, 3 ex., 05.10.2013.	Holarctic, xerothermophilous, hemiedaphobiont.
	Genus <i>Xenylla</i> Tullberg, 1869		
7.	<i>Xenylla boernerii</i> (Axelson, 1905)	Forest, litter, 52 ex., 21.08. 2005.	European, bryophilous, silvicolous, hemiedaphobiont.
8.	<i>Xenylla brevicauda</i> Tullberg, 1869	Forest, litter, 36 ex., 13.05.1997.	Palaeartic, meso-xerophilous, silvicolous, prefers dry habitats, hemiedaphobiont.
9.	<i>Xenylla brevisimilis brevisimilis</i> Stach, 1949	Forest, litter, 2 ex., 21.08.2005.	Mediterranean, thermophilous, silvicolous, hemiedaphobiont.
	Genus <i>Willemia</i> Börner, 1901		
10.	<i>Willemia intermedia</i> Mills, 1934	Forest, litter, 3 ex., 21.08. 2005.	Holarctic, micetophagous euedaphobiont.
	Family Neanuridae		
	Genus <i>Friesea</i> Dalla Torre, 1895		
11.	<i>Friesea mirabilis</i> (Tullberg, 1871)	Forest, litter, 2 ex., 21.05.1996; meadow, 1 ex., 19.05.2004.	Cosmopolitan, ubiquitous, acidophilous hemiedaphobiont.
12.	<i>Friesea octooculata</i> Stach, 1949	Forest, litter, 2 ex., 13.05.1997.	Mediterranean, silvicolous, meso-hygrophilous hemiedaphobiont.
	Genus <i>Pseudachorutella</i> Stach, 1949		
13.	<i>Pseudachorutella assigillata</i> Börner, 1901	Forest, litter, 1 ex., 13.05.1997.	Palaeartic, silvicolous hemiedaphobiont.
	Genus <i>Pseudachorutes</i> Tullberg, 1871		
14.	<i>Pseudachorutes dubius</i> Krausbauer, 1898	Forest, wood decompose, 1 ex., 01.06.2005, litter, 2 ex., 21.08. 2005.	Palaeartic, silvicolous, littericolous hemiedaphobiont.

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
15.	<i>Pseudachorutes subcrassus</i> Tullberg, 1871	Forest, litter, 1 ex., 10.07.1997, 2 ex., 21.08.2005; alfalfa, 1 ex., 13.10.2010	Palaeartic, mesophilous, silvicolous hemiedaphobiont.
	Genus <i>Deutonura</i> Cassagnau, 1979		
16.	<i>Deutonura albella</i> (Stach, 1920)	Forest, litter, 6 ex., 19.05.2004, 2 ex., 21.08.2005, wood decompose, 2 ex., 13.10.2010.	European, hemiedaphic, mesophilous, silvicolous xylobiont.
17.	<i>Deutonura stachi</i> (Gisin, 1952)	Forest, litter, 1 ex., 19.05.2004.	European, hemiedaphic, mesophilous, silvicolous xylobiont.
	Genus <i>Neanura</i> Mac Gillivray, 1893		
18.	<i>Neanura muscorum</i> (Templeton, 1835)	Forest, litter, 2 ex., 24.10.2004; meadow, 1 ex., 21.08.2005	European, hemiedaphic, mesophilous, silvicolous xylobiont.
19.	<i>Neanura moldavica</i> Bușmachi & Deharveng, 2008	Forest, soil, 3 ex., 15.10.2004, 2 ex., 21.08.2005.	Endemic, hemiedaphic, mesophilous, silvicolous xylobiont
	Genus <i>Micranurida</i> Börner, 1901		
20.	<i>Micranurida pygmaea</i> Börner, 1901	Forest, soil, 3 ex., 01.06.1994, 2 ex., litter, 10.07.1997, wood decompose, 2 ex., 05.10.2013; meadow, 1 ex., 21.08.2005.	Cosmopolitan, eurytopic, hygrophilous, acidophilous, euedaphobiont.
	Genus <i>Thaumanura</i> Börner, 1932		
21.	<i>Thaumanura carolii</i> (Stach, 1920)	Forest, wood decompose, 1 ex., 13.10.2010.	European, silvicolous xylophagous epiedaphobiont.
	Family Odontellidae		
	Genus <i>Superodontella</i> Stach, 1949		
22.	<i>Superodontella montemaceli</i> Arbea, Weiner, 1992	Forest, wood decompose, 2 ex., 16.02.2009, 3 ex., 05.10.2013.	Poland, Moldova, Ukraine, hemiedaphic, mesophilous, silvicolous species.
23.	<i>Superodontella lamellifera</i> (Axelson, 1903)	<i>Pinus</i> plantation, litter, 2 ex., 19.05.2004; forest, wood decompose, 2 ex., 05.10.2013.	Cosmopolitan, hemiedaphic, mesophilous, silvicolous species.
	Family Onychiuridae		
	Genus <i>Deuteraphorura</i> Absolon, 1901		
24.	<i>Deuteraphorura silvaria</i> (Gisin, 1952)	Forest, soil, 2 ex., 13.05.1997; alfalfa, 5 ex., 13.10.2010.	European, ruderal, troglophilous, euedaphobiont.
	Genus <i>Micraphorura</i> Bagnall, 1949		
25.	<i>Micraphorura unalica</i> (Khanislamova, 1986)	Alfalfa, 9 ex., 10.12.2010.	Palaeartic, littericolous euedaphobiont.
	Genus <i>Orthonychiurus</i> Stach, 1954		
26.	<i>Orthonychiurus rectopapillatus</i> (Stach, 1933)	Forest, wood decompose, 2 ex., 13.05.1997, 2 ex., 01.06.2005.	European, silvicolous euedaphobiont.
27.	<i>Orthonychiurus stachianus</i> (Bagnall, 1939)	Forest, wood decompose, 27 ex., 01.06.2005.	European, hygrophilous euedaphobiont.
	Genus <i>Onychiuroides</i> Bagnall, 1948		

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
28.	<i>Onychiuroides granulatus</i> (Stach, 1930)	Forest, wood decompose, 4 ex., 09.10.2008.	Palaeartic, euedaphobiont.
	Genus <i>Protaphorura</i> Absolon, 1901		
29.	<i>Protaphorura campata</i> (Gisin, 1952)	Forest, litter, 4 ex., 13.05.1997.	Palaeartic, euedaphobiont of open habitat.
30.	<i>Protaphorura cancellata</i> (Gisin, 1956)	Alfalfa, 2 ex., 10.12.2010.	Palaeartic, euedaphobiont.
31.	<i>Protaphorura sakatoi</i> (Yosii, 1966)	Forest, litter, 124 ex., 21.08.2005, 11 ex., 13.10.2010.	Palaeartic, xerothermophilous euedaphobiont.
32.	<i>Protaphorura subarmata</i> (Gisin, 1957)	Forest, moss, 20 ex., 01.06.2005.	European, eurytopic euedaphobiont.
	Family Tullbergiidae		
	Genus <i>Doutnacia</i> Rusek, 1974		
33.	<i>Doutnacia xerophila</i> Rusek, 1974	Forest, soil, 2 ex., 01.05.2005; alfalfa, soil, 4 ex., 13.10.2010.	European, xerothermophilous euedaphobiont.
	Genus <i>Mesaphorura</i> Börner, 1901		
34.	<i>Mesaphorura critica</i> Ellis, 1976	Forest, soil, 1 ex., 21.08.2005, 2 ex., 13.10.2010.	Palaeartic, xerothermophilous euedaphobiont.
35.	<i>Mesaphorura florae</i> Simon, Ruiz, Martin & Lucianez, 1994	Forest, litter, 12 ex., 21.08.2005.	European, mesophilous euedaphobiont.
36.	<i>Mesaphorura hyllophila</i> Rusek, 1982	Forest, soil, 3 ex., 01.05.2005, 8 ex., 21.08.2005; alfalfa, soil, 3 ex., 13.10.2010.	Cosmopolitan, eurytopic euedaphobiont.
37.	<i>Mesaphorura krausbaueri</i> Börner, 1901	Forest, soil, 3 ex., 10.04.2006.	Cosmopolitan, eurytopic euedaphobiont.
38.	<i>Mesaphorura yosii</i> (Rusek, 1967)	Alfalfa, soil, 1 ex., 13.10.2010.	Holarctic, silvicolous, acidophilous euedaphobiont.
	Genus <i>Metaphorura</i> Stach, 1954		
39.	<i>Metaphorura affinis</i> (Börner, 1902)	Alfalfa, soil, 1 ex., 13.10.2010.	Palaeartic, xerothermophilous euedaphobiont.
	Family Isotomidae		
	Genus <i>Desoria</i> Nicolet, 1841		
40.	<i>Desoria fennica</i> (Reuter, 1895)	Forest, wood decompose, 1 ex., 13.05.1998.	Palaeartic, eurytopic epigeant.
41.	<i>Desoria olivacea</i> (Tullberg, 1871)	Forest, wood decompose, 8 ex., 01.06.2005.	Holarctic, hygro-mesophilous, bryophilous epigeant.
42.	<i>Desoria propinqua</i> (Axelson, 1902)	Low bush near the forest, 1 ex., 13.05.1998.	Holarctic, eurytopic, littiericolous epigeant.
43.	<i>Desoria trispinata</i> (Mac Gillivray, 1896)	Forest, wood decompose, 79 ex., 01.06.2005; alfalfa, 4 ex., 13.10.2010.	Cosmopolitan, littiericolous epigeant.
44.	<i>Desoria violacea</i> (Tullberg, 1876)	Forest, litter, 2 ex., 10.07.1997.	European, littiericolous, meadow epigeant.
	Genus <i>Folsomia</i> Willem, 1902		
45.	<i>Folsomia candida</i> Willem, 1902	Forest, litter, 2 ex., 10.07.1997, wood decompose; 52 ex., 01.06.2005; alfalfa, 2 ex., 13.10.2010.	Cosmopolitan, hemiedaphic, ubiquitous, thermophilous.
46.	<i>Folsomia manolachei</i> Bagnall, 1939	Forest, soil, 29 ex., 18.09.2000.	Palaeartic, hemiedaphic, eurytopic species.

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
47.	<i>Folsomia penicula</i> Bagnall, 1939	Forest, litter, 40 ex., 24.06.1997, 87 ex., 19.05.2004, 9 ex., 05.10.2013.	Palearctic, hemiedaphic, silvicolous, littericolous.
48.	<i>Folsomia quadrioculata</i> (Tullberg, 1871)	Forest, litter, 6 ex., 13.05.1997, 34 ex., 21.08.2005, wood decompose, 28 ex., 01.06.2005.	Holarctic, hemiedaphic, eurytopic species.
	Genus <i>Folsomides</i> Stach, 1922		
49.	<i>Folsomides parvulus</i> Stach, 1922	Pasture, soil, 2 ex., 24.06.1996.	Cosmopolitan, xerothermophilous, euedaphobiont.
	Genus <i>Hemisotoma</i> Bagnall, 1949		
50.	<i>Hemisotoma thermophila</i> (Axelson, 1900)	Forest, wood decompose, 19 ex., 01.06.2005.	Cosmopolitan, nitrophilous, xerothermophilous hemiedaphobiont.
	Genus <i>Isotoma</i> Bourlet, 1839		
51.	<i>Isotoma viridis</i> Bourlet, 1839	Forest, litter, 3 ex., 01.06.1994, 11 ex., 10.07.1997, 13 ex., 21.08.2005; <i>Picea</i> plantation, 35 ex., 01.06.1994; apple orchard, 7 ex., 01.06.1994; meadow, 3 ex., 26.08.2003, 1 ex., 14.10.2004.	Holarctic, ubiquitous, mesophilous epigeont.
52.	<i>Isotoma anglicana</i> Lubbock, 1862	Apple orchard, 2 ex., 13.10.2010.	European, eurytopic epigeont.
	Genus <i>Isotomiella</i> Bagnall, 1939		
53.	<i>Isotomiella minor</i> (Schäffer, 1896)	<i>Pinus nigra</i> plantation, 5 ex., 19.05.2004; meadow, 27 ex., 21.08.2005; alfalfa, 3 ex., 13.10.2010, 6 ex., 05.10.2013.	Holarctic, ubiquitous, mesophilous euedaphobiont.
	Genus <i>Isotomodes</i> Linnaniemi, 1907		
54.	<i>Isotomodes productus</i> (Axelson, 1906)	Alfalfa, 1 ex., 10.12.2010.	Cosmopolitan, xerothermophilous euedaphobiont.
	Genus <i>Isotomurus</i> Börner, 1903		
55.	<i>Isotomurus palustris</i> (Müller, 1776)	Meadow, 1 ex., 02.06.2001, 9 ex., 21.08.2005.	Holarctic, hygrophilous, algovorous epigeont.
	Genus <i>Parisotoma</i> Bagnall, 1940		
56.	<i>Parisotoma notabilis</i> (Schäffer, 1896)	Forest, litter, 8 ex., 01.06.1994, 57 ex., 21.08.2005, wood decompose, 23 ex., 01.06.2005, 12 ex., 05.10.2013; <i>Picea</i> plantation, 43 ex., 01.06.1994; meadow, 9 ex., 19.05.2004.	Cosmopolitan, ubiquitous, mesophilous, alkalophilous, hemiedaphobiont.
	Genus <i>Proisotoma</i> Börner, 1901		
57.	<i>Proisotoma minuta</i> (Tullberg, 1871)	Forest, litter, 9 ex., 19.05.2004, wood decompose, 9 ex., 01.06.2005; <i>Pinus nigra</i> plantation, 35 ex., 19.05.2004; alfalfa, 1 ex., 13.10.2010.	Cosmopolitan, mesophilous, thermophilous, compost hemiedaphobiont.
	Genus <i>Proisotomodes</i> Bagnall, 1949		

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
58.	<i>Proisotomodes bipunctatus</i> (Axelson, 1903)	Forest, litter, 12 ex., 10.07.1997, 7 ex., 21.08.2005, wood decompose, 12 ex., 05.10.2013.	Palearctic, xerotolerant hemiedaphobiont.
	Family Tomoceridae		
	Genus Pogonognathellus Paclt, 1944		
59.	<i>Pogonognathellus flavescens</i> (Tullberg, 1871)	Meadow, 3 ex., 26.08.2003; forest, wood decompose, 4 ex., 29.02.2008.	Holarctic, hygrophilous, acidophilous, silvicolous edaphobiont.
60.	<i>Pogonognathellus longicornis</i> (Müller, 1776)	Forest, wood decompose, 1 ex., 29.02.2008.	Holarctic, hygrophilous, acidophilous, silvicolous edaphobiont.
	Genus Tomocerina Yosii, 1955		
61.	<i>Tomocerina minuta</i> (Tullberg, 1876)	Forest, litter, 2 ex., 10.07.1997, wood decompose, 2 ex., 13.05.1998.	Holarctic, mesophilous, silvicolous, littericolous edaphobiont.
	Genus Tomocerus Nicolet, 1842		
62.	<i>Tomocerus minor</i> (Lubbock, 1862)	Forest, litter, 2 ex., 10.07.1997, 1 ex., 13.05.1998, 1 ex., 26.08.2003, 5 ex., 19.05.2004.	Cosmopolitan, meso-hygrophilous, silvicolous edaphobiont.
63.	<i>Tomocerus vulgaris</i> (Tullberg, 1871)	Forest, wood decompose, 7 ex., 01.06.2005, 3 ex., 29.02.2008, 4 ex., 05.10.2013; <i>Pinus</i> plantation, litter, 3 ex., 19.05.2004.	Holarctic, mesophilous, silvicolous edaphobiont.
	Family Cyphoderidae		
	Genus Cyphoderus Nicolet, 1842		
64.	<i>Cyphoderus albinus</i> Nicolet, 1842	<i>Betula</i> plantation, 3 ex., 19.05.2004.	Palearctic, euedaphic, mesophilous, myrmecophilous euedaphobiont.
65.	<i>Cyphoderus bidenticulatus</i> (Parona, 1888)	Apple orchard, 2 ex., 11.08.2003.	Mediterranean, euedaphic, mesophilous, myrmecophilous euedaphobiont.
	Family Entomobryidae		
	Genus Entomobrya Rondani, 1861		
66.	<i>Entomobrya lanuginosa</i> (Nicolet, 1842)	Forest, litter, 2 ex., 13.05.1997, 1 ex., 10.10.1997, 1 ex., 30.09.2011.	Palearctic, eurytopic, atmobiont.
67.	<i>Entomobrya marginata</i> Tullberg, 1871	Alfalfa, 2 ex., 13.10.2010.	Cosmopolitan, mesophilous, eurytopic, atmobiont.
68.	<i>Entomobrya multifasciata</i> (Tullberg, 1871)	<i>Betula</i> plantation, litter, 2 ex., 19.05.2004.	Palearctic, xerothermophilous, eurytopic, atmobiont.
69.	<i>Entomobrya muscorum</i> (Nicolet, 1842)	Forest, litter, 2 ex., 01.06.1994.	Holarctic, bryophilous atmobiont.
70.	<i>Entomobrya nivialis</i> (Linnaeus, 1758)	Forest, litter, 3 ex., 13.10.2010.	Cosmopolitan, corticolous, macrophytobiont.
71.	<i>Entomobrya puncticola</i> Uzel, 1891	Apple orchard, 3 ex., 01.06.1994.	European, macrophytobiont.
72.	<i>Entomobrya quinquelineata</i> Börner, 1901	Forest, litter, 2 ex., 13.05.1997.	Mediterranean, xerothermophilous atmobiont.
	Genus Heteromurus Wankel, 1860		

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
73.	<i>Heteromurus major</i> (Moniez, 1889)	Forest, litter, 7 ex., 13.05.1997; meadow, 7 ex., 21.08.2005.	Mediterranean, xerothermophilous, littiericolous hemiedaphobiont.
74.	<i>Heteromurus nitidus</i> (Templeton, 1835)	Forest, litter, 2 ex., 13.05.1997, wood decompose, 3 ex., 05.10.2013.	Cosmopolitan, mesophilous, eurytopic hemiedaphobiont.
	Genus <i>Lepidocyrtus</i> Bourlet, 1839		
75.	<i>Lepidocyrtus curvicolis</i> Bourlet, 1839	Forest, litter, 3 ex., 01.06.1994.	Holarctic, silvicolous, mesophilous epigeont.
76.	<i>Lepidocyrtus cyaneus</i> Tullberg, 1871	Meadow, 5 ex., 26.08.2003; forest, litter, 3 ex., 11.08.2003, 19 ex., 21.08.2005.	Holarctic, mesophilous, littiericolous epigeont.
77.	<i>Lepidocyrtus lanuginosus</i> (Gmelin, 1788)	Forest, litter, 1 ex., 13.05.1997, 2 ex., 11.08.2003.	Holarctic, littiericolous epigeont.
78.	<i>Lepidocyrtus lignorum</i> (Fabricius, 1775)	Forest, litter, 24 ex., 01.06.1994, 2 ex., 13.07.1997, moss, 7 ex., 01.06.2005; meadow, 6 ex., 21.08.2005.	Holarctic, eurytopic, meso-and hygrophilous epigeont.
79.	<i>Lepidocyrtus paradoxus</i> Uzel, 1890	Forest, litter, 2 ex., 13.05.1997; meadow, 4 ex., 21.08.2005.	Holarctic, mesophilous macrophytobiont.
80.	<i>Lepidocyrtus violaceus</i> Lubbock, 1873	Forest, litter, 10 ex., 10.07.1997.	Holarctic, silvicolous epigeont.
	Genus <i>Orchesella</i> Templeton, 1835		
81.	<i>Orchesella cincta</i> (Linnaeus, 1758)	Apple orchard, 2 ex., 01.06.1994.	Holarctic, mesophilous, silvicolous edaphobiont.
82.	<i>Orchesella multifasciata</i> Stscherbakow, 1898	Forest, moss, 5 ex., 19.05.2004, 2 ex., 14.10.2004, 1 ex., 27.03.2005, 28 ex., 01.06.2005; meadow, 2 ex., 21.08.2005.	European, xerothermophilous, silvicolous edaphobiont.
83.	<i>Orchesella pseudobifasciata</i> Stach, 1960	Forest, moss, 1 ex., 14.03.2007.	European, silvicolous, bryophilous edaphobiont.
84.	<i>Orchesella xerothermica</i> Stach, 1960	Forest, litter, 5 ex., 10.07.1997, 2 ex., 19.05.2004, 3 ex., 21.08.2005.	European, xerothermophilous, silvicolous edaphobiont.
	Genus <i>Pseudosinella</i> Schäffer, 1897		
85.	<i>Pseudosinella alba</i> (Packard, 1873)	Apple orchard, 1 ex., 01.06.1994; forest, wood decompose, 1 ex., 01.06.1994.	Cosmopolitan, micetophagous, compost euedaphobiont.
86.	<i>Pseudosinella albida</i> (Stach, 1930)	Forest, litter, 4 ex., 17.10.1997.	Mediterranean, silvicolous, littiericolous hemiedaphobiont.
87.	<i>Pseudosinella horaki</i> Rusek, 1985	Forest, litter, 3 ex., 01.06.1994, 4 ex., 13.05.1995, 3 ex., 17.10.1997, 11 ex., 26.08.2003, 56 ex., 21.08.2005, 2 ex., 13.10.2010.	European, littiericolous hemiedaphobiont.
88.	<i>Pseudosinella imparipunctata</i> Gisin, 1953	Forest, litter, 2 ex., 10.07.1997.	European, mesophilous, hemiedaphic, littiericolous.
89.	<i>Pseudosinella moldavica</i> Gama, Bușmachi, 2002	Forest, litter, 2 ex., 13.05.1995.	European, xerothermophilous hemiedaphobiont.
90.	<i>Pseudosinella octopunctata</i> Börner, 1901	<i>Betula</i> plantation, litter, 3 ex., 19.05.2004; alfalfa, soil, 1 ex., 10.12.2010.	Cosmopolitan, eurytopic hemiedaphobiont.

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
91.	<i>Pseudosinella simpatica</i> Gama, Buşmachi, 2002	<i>Robinia pseudoacacia</i> plantation, litter, 1 ex., 02.05.1996.	Moldova, silvicolous, littericolous euedaphobiont.
	Genus <i>Seira</i> Lubbock, 1869		
92.	<i>Seira domestica</i> (Nicolet, 1842)	Forest, litter, 6 ex., 10.07.1997.	European, ubiquitous, thermophilous hemiedaphobiont.
93.	<i>Seira ferrarii</i> Parona, 1888	Alfa, 3 ex., 22.09.1992.	Mediterranean, thermophilous hemiedaphobiont.
	Genus <i>Willowsia</i> Shoebottom, 1917		
94.	<i>Willowsia nigromaculata</i> (Lubbock, 1873)	Forest, under the bark of tree, 1 ex., 24.09.2011; <i>Pinus</i> plantation, litter, 4 ex., 19.05.2004.	Cosmopolitan, corticolous microphitobiont.
	Family Neelidae		
	Genus <i>Megalothorax</i> Willem, 1900		
95.	<i>Megalothorax minimus</i> Willem, 1900	Forest, moss, 2 ex., 10.07.1997, litter, 1 ex., 26.08.2003, 2 ex., 01.06.2005.	Cosmopolitan, mesophilous, eurytopic euedaphobiont.
	Genus <i>Neelides</i> Caroli, 1912		
96.	<i>Neelus murinus</i> (Folsom, 1896)	Forest, moss, 3 ex., 01.06.2005, wood decompose, 3 ex., 13.10.2010, 7 ex., 05.10.2013.	Cosmopolitan, silvicolous euedaphobiont.
	Family Sminthuridae		
	Genus <i>Sphaeridia</i> Linnaniemi, 1912		
97.	<i>Sphaeridia pumilis</i> (Krausbauer, 1898)	Forest, litter, 3 ex., 01.06.1994, moss, 28 ex., 01.06.2005.	Cosmopolitan, mesophilous, ubiquitous edaphobiont.
	Family Arrhopalitidae		
	Genus <i>Arrhopalites</i> Börner, 1906		
98.	<i>Arrhopalites cacus</i> (Tullberg, 1871)	Forest, litter, 1 ex., 13.05.1998.	Palearctic, mesophilous euedaphobiont.
	Genus <i>Pygmarrhopalites</i> Vargovitsh, 2009		
99.	<i>Pygmarrhopalites</i> sp.	Meadow, 2 ex., 26.08.2003; forest, litter, 1 ex., 13.10.2010.	Euedaphic, mesophilous species.
	Family Katiannidae		
	Genus <i>Sminthurinus</i> Börner, 1901		
100.	<i>Sminthurinus aureus</i> (Lubbock, 1862)	Forest, litter, 2 ex., 17.10.1997, 2 ex., 14.10.2004, moss, 2 ex., 01.06.2005; meadow, 4 ex., 11.08.2003.	Palearctic, eurytopic, mesophilous epigeont.
101.	<i>Sminthurinus bimaculatus</i> , Axelson, 1902	Meadow, 1 ex., 26.08.2003, 7 ex., 19.05.2004.	Palearctic, hygrophilous epigeont.
102.	<i>Sminthurinus elegans</i> (Fitch, 1863)	Meadow, 6 ex., 19.05.2004.	European, xerothermophilous, eurytopic epigeont.
103.	<i>Sminthurus niger</i> (Lubbock, 1868)	Forest, litter, 2 ex., 01.06.1994.	Palearctic, eurytopic epigeont.
	Genus <i>Gisinianus</i> Betsch, 1977		
104.	<i>Gisinianus flammeolus</i> (Gisin, 1957)	Meadow, 1 ex., 11.08.2003.	Palearctic, epigeont of open habitat.

Nº	Taxon	Habitat, number of specimens and data collections	Distribution and ecology
	Family Dicyrtomidae		
	Genus <i>Dicyrtoma</i> Bourlet, 1842		
105.	<i>Dicyrtoma fusca</i> (Lubbock, 1873)	Forest, 1 ex., 14.10.2004; meadow, 1 ex., 24.09.2011.	Holarctic, mesophilous epigeont.
	Genus <i>Dicyrtomina</i> Börner, 1903		
106.	<i>Dicyrtomina flavosignata</i> (Tullberg, 1871)	Forest, 2 ex., 30.09.2011.	Palearctic, epigeont.
107.	<i>Dicyrtomina minuta</i> (Fabricius, 1783)	Forest, moss on wood decomposes, 1 ex., 10.04.2006.	Holarctic, mesophilous epigeont.
	Genus <i>Prenothrix</i> Börner, 1906		
108.	<i>Prenothrix atra</i> (Linnaeus, 1868)	Forest, litter, 1 ex., 17.10.1997, wood decompose, 2 ex., 05.10.2013.	Palearctic, silvicolous epigeont.
	Family Sminthuridae		
	Genus <i>Capraínea</i> Dallai, 1970		
109.	<i>Capraínea marginata</i> (Schott, 1893)	Meadow, 1 ex., 21.05.1996; forest, moss, 11 ex., 01.06.2005.	Palearctic, silvicolous epigeont.
	Genus <i>Lipothrix</i> Börner, 1906		
110.	<i>Lipothrix lubbocki</i> (Tullberg, 1872)	Meadow, 2 ex., 21.05.1996, 4 ex., 11.08.2003, 4 ex., 26.08.2003; forest, litter, 2 ex., 17.10.1997.	Palearctic, silvicolous epigeont.
	Genus <i>Sminthurus</i> Latreille, 1804		
111.	<i>Sminthurus viridis</i> (Linnaeus, 1758)	Alfalfa, 3 ex., 05.10.2010.	Holarctic, mesophilous macrophytobiont.
	Genus <i>Spatulosminthurus</i> Betsch & Betsch-Pinot, 1984		
112.	<i>Spatulosminthurus flaviceps</i> (Tullberg, 1871)	Forest, litter, 3 ex., 01.06.1994; meadow, 1 ex., 21.05.1996.	Palearctic, mesophilous, silvicolous edaphobion

AQUATIC BEETLES FAUNA (COLEOPTERA: GYRINIDAE, HALIPLIDAE, NOTERIDAE, DYTISCIDAE AND HYDROPHILIDAE) FROM THE REPUBLIC OF MOLDOVA

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Abstract: The paper presents the list of the species of Gyrinidae, Haliplidae, Noteridae, Dytiscidae and Hydrophilidae families of aquatic beetles from the Republic of Moldova. The 59 species belong to 35 genera and 9 subfamilies. The list is based on literature sources, collections and faunistic studies made by the authors.

Keywords: Aquatic beetles, Gyrinidae, Haliplidae, Noteridae, Dytiscidae, Hydrophilidae, Republic of Moldova.

Introduction

Beetles represent one of the largest orders among aquatic animals (Jach, Balke, 2008). Aquatic beetle fauna in the Republic of Moldova is still poorly known. The families Gyrinidae, Haliplidae, Noteridae and Dytiscidae belong to Caraboidea superfamily, suborder Adephaga and the Hydrophilidae family belongs to Hydrophiloidea superfamily, suborder Polyphaga.

In the world fauna about 750 species from 13 genera of Gyrinidae are known, mostly from tropical region. Adults and larvae of all species are strictly aquatic. The majority of the Gyrinidae species lives in running water (Beutel, Roughley, 2005; Mazzoldi, 1995). The European fauna of Gyrinidae is represented by one subfamily Gyrinae and two genera *Aulonogyrus* and *Gyrinus*, both present in the Republic of Moldova as well.

About 200 species in five genera are known for Haliplidae family all over the world, but more diverse in the northern temperate regions. Larvae and adults of Haliplidae species are truly aquatic. They prefer mainly stagnant water but some species are found in lotic habitats (Vondel, 2005). In Europe only three genera are known, two of them *Peltodytes* and *Haliplus* are found in the Republic of Moldova.

Altogether 250 species in three subfamilies and 14 genera have been described for Noteridae family. Adults and larvae are aquatic. Noteridae are commonly found in stagnant water between roots of water plants (Nilsson, 2005). European fauna is represented by one subfamily Noterinae and two genera. Only one genus *Noterus* was found in the Republic of Moldova.

Dytiscidae is the largest family of aquatic beetles, with almost 4000 species and 160 genera included in 10 subfamilies. Larvae and adults of almost all species are aquatic; they live in a wide variety of freshwater habitats: stagnant water, running water and groundwater (Larson et al., 2000; Nilsson, 2001). For European fauna six subfamilies are known: Agabinae, Colymbetinae, Copelatinae, Dytiscinae, Hydroporinae and Laccophilinae. In the Republic of Moldova following subfamilies and genera occur: Agabinae (*Agabus*, *Ilybius* and *Platambus*), Colymbetinae (*Colymbetes* and *Rhantus*), Copelatinae (*Copelatus*), Dytiscinae (*Acilius*, *Graphoderus*, *Cybister*, *Dytiscus* and *Hydaticus*), Hydroporinae (*Graptodytes*, *Hydroglyphus*, *Hygrotus*, *Hyphydrus*) and Laccophilinae (*Laccophilus*).

Around 2835 species in 169 genera and 4 subfamilies were described for Hydrophilidae from all continents. Altogether, about 70% of Hydrophilidae are aquatic, adults and larvae of most species live in stagnant water (Hansen, 1991, 1999; Short, Hebauer, 2005). In Europe Hydrophilidae are represented by 29 genera from 4 subfamilies. In the Republic of Moldova 14 genera from one subfamily are known so far.

The first faunistic data on aquatic beetles from the Republic of Moldova has been recorded by Miller and Zubovskii (1917), later on completed by Ruscinsky (1933–1934); additional information on some aquatic beetle species has been presented by Medvedev and Shapiro (1957), Yaroshenko (1957), Bacal, Munteanu, Toderas (2013) and Molotievskiy, Bacal (2015). Ecological data regarding aquatic beetles were presented by Ostafichuk (1983) and Neculiseanu et al. (2003, 2007).

Material and methods

The following list of aquatic beetles is based on a combination of literature records, examination of museum specimen collection of the Institute of Zoology, Academy of Sciences of Moldova and sampled material during 2013–2014 years from different aquatic basins from the Republic of Moldova. Insects were collected using light traps and a drag-type net. The nomenclature of the beetle species is based primarily on the works of Kryzhanovskij (1965), Lobl and Smetana (2004) and Bouchard et al. (2011).

Results and discussions

The fauna of the aquatic beetles of the Republic of Moldova is represented by 59 species, 35 genera, 9 subfamilies and 5 families: Gyrinidae (2 species from 2 genera), Haliplidae (2 species, 2 genera), Noteridae (2 species, 1 genus), Dytiscidae (29 species, 16 genera) and Hydrophilidae (24 species, 14 genera).

Family GYRINIDAE Latreille, 1810

Subfamily Gyrininae Latreille, 1810

Genus *Aulonogyrus* Motschulsky, 1853

A. concinnus Klug, 1834

Examined material: 01.07–31.08.1905, Vadul lui Voda (E. Miller, N. Zubovskiy).

Published records: Miller, Zubovskiy, 1917: 123; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:145; Neculiseanu et al., 2005:63; Bacal, Munteanu, Toderas, 2013:416.

Distribution: East Palearctic, Near East and North Africa.

Genus *Gyrinus* O.F. Muller, 1764

G. natator Linnaeus, 1758

Examined material: 18.03.1901, Chisinau (E. Miller, N. Zubovskiy).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:145; Bacal, Munteanu, Toderas, 2013:416.

Distribution: East Palearctic.

Family HALIPLIDAE Aube, 1836

Genus *Peltodytes* Regimbart, 1878

P. caesus (Duftschmid, 1805)

Examined material: 03.08.1909, Voinova (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:143; Bacal, Munteanu, Toderas, 2013:421.

Distribution: Near East and North Africa.

Genus *Haliplus* Latreille, 1802

H. ruficollis (De Geer, 1774)

Examined material: 11.07.1905, Voinova (E. Miller, N. Zubovskiy); Voinova (S. Medvedev, D. Shapiro); 16.12.2013, 3 ex., Braniște, 29.07.2014, 3 ex., Otaci (O. Munjiu).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:143; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

Family NOTERIDAE C.G. Thomson, 1860

Subfamily Noterinae Regimbart, 1878

Genus *Noterus* Clairville, 1806

N. clavicornis (De Geer, 1774)

Examined material: 24.04.1904, Chisinau, (E. Miller, N. Zubovskiy); 21.05.1932, 28.07.1932, 06.05.1933, Bularda (A. Ruscinsky).

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:134; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

N. crassicornis (O.F. Muller, 1776)

Examined material: 21.05.1932, 28.07.1932, 06.05.1933, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic and Near East.

Family DYTISCIDAE Leach, 1815

Subfamily Agabinae Thomson, 1867

Genus *Agabus* Leach, 1817

A. uliginosus (Linnaeus, 1761)

Examined material: 24.05.1905, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic.

A. undulatus (Schränk, 1776)

Examined material: 02.06.1932, 2 ex., Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic.

Genus *Platambus* Thomson, 1859

P. maculatus (Linnaeus, 1758)

Examined material: 02.10.2014, 2 ex., Braniște; 16.12.13, 4 ex., Braniște (O. Munjiu).

Distribution: East Palearctic and Near East.

Genus *Ilybius* Erichson, 1832

I. fenestratus (Fabricius, 1781)

Examined material: 05.07.1931, 12.07.1931, 02.06.1932, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic.

I. subaeneus Erichson, 1837

Examined material: 05.08.1929, Chisinau (E. Miller, N. Zubovskiy), 02.06.1932, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic, Near East and Nearctic region.

Subfamily Colymbetinae Erichson, 1837

Genus *Colymbetes* Clairville, 1806

C. fuscus (Linnaeus, 1758)

Examined material: 21.06.1917, 23.06.1917, 23.08.1917, 27.10.1917, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

Genus *Rhantus* Dejean, 1833

R. frontalis (Marsham, 1802)

Examined material: 14.06.1931, 05.07.1931, 12.07.1931, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:135; Neculiseanu et al., 2003:42.

Distribution: East Palearctic and Near East.

R. exsoletus (Forster, 1771)

Examined material: 29.06.1987, 4 ex., Giurgiulesti (V. Ostafichuk).

Published records: Molotievskiy Munteanu, Bacal, 2015:153.

Distribution: East Palearctic.

R. suturalis (W.S. Macleay, 1825)

Examined material: 12.08.1987, 1 ex. Giurgiulesti (V. Ostafichuk)

Published records: Molotievskiy Munteanu, Bacal, 2015:153.

Distribution: Australian region, East Palearctic Near East, North Africa and Oriental region.

R. bistratus (Bergsträsser, 1778)

Examined material: 14.06.1931, 21.06.1931, 20.07.1932, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:135.

Distribution: East Palearctic and Near East.

Subfamily Copelatinae Branden, 1885

Genus *Copelatus* Erichson, 1832

C. haemorrhoidalis (Fabricius, 1787)

Examined material: 22.04.1923, 19.06.1930, 23.07.1930, Chisinau (E. Miller, N. Zubovskiy); 21.06.1927, 05.07.1931, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic and Near East.

Subfamily Dytiscinae Leach, 1815

Genus *Acilius* Leach, 1817

A. sulcatus (Linnaeus, 1758)

Examined material: 12.05.1927, 14.05.1927, 27.05.1927, 03.06.1927, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:135.

Distribution: East Palearctic and Near East.

A. canaliculatus (Nicolai, 1822)

Examined material: 21.06.1927, 1 ex., Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:135.

Distribution: East Palearctic.

Genus *Graphoderus* Dejean, 1833

G. cinereus (Linnaeus, 1758)

Examined material: 20.04.1906, Chisinau (E. Miller, N. Zubovskiy); 21.06.1931, Bularda (A. Ruscinsky); Chisinau (S. Medvedev, D. Shapiro)

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:135; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

Genus *Cybister* Curtis, 1827

C. lateralimarginalis (De Geer, 1774)

Examined material: 13.04–20.08.1917, Chisinau, 08.05.1901, Voinova (E. Miller, N. Zubovskiy); Chisinau, Voinova (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:134; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and North Africa.

Genus *Dytiscus* Linnaeus, 1758

D. circumcinctus (Ahrens, 1811)

Examined material: 14.05.1900, Chisinau (E. Miller, N. Zubovskiy).

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:134; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:145; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and Nearctic region.

D. circumflexus Fabricius, 1801

Examined material: 16.05.1904, Vadul lui Voda (E. Miller, N. Zubovskiy); Vadul lui Voda (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:145; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and North Africa.

D. dimidiatus Bergstrasser, 1778

Examined material: 23.09-04.10.1917, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:189; Ostafichuk, 1983:145; Neculiseanu et al., 2005:69; Bacal, Munteanu, Toderas, 2013:421.

Distribution: Near East.

D. marginalis Linnaeus, 1758

Examined material: abundant.

Published records: Ostafichuk, 1983:144; Neculiseanu et al., 2005:68.

Distribution: East Palearctic and Near East.

Genus *Hydaticus* Leach, 1817

H. transversalis (Pontoppidan, 1763)

Examined material: 23.06.1906, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro); 05.07-06.07.1987, 1 ex., Giurgiulesti (V. Ostafichuk).

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:134; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

Subfamily Hydroporinae Aube, 1836

Genus *Hygrotus* Stephens, 1828

H. confluens (Fabricius, 1787)

Examined material: 23.09.1901, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Medvedev, Shapiro, 1957:1189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and North Africa.

H. impressopunctatus (Schaller, 1783)

Examined material: 06.06.1909, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:134; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and Nearctic region.

H. inaequalis (Fabricius, 1776)

Examined material: 27.05.1927, 05.07.1931, 12.07.1931, Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic, Near East and North Africa.

Genus *Hydroglyphus* Motschulsky, 1853

H. geminus Fabricius, 1792

Examined material: abundant.

Published records: Ruscinsky, 1934:134

Distribution: East Palearctic, Near East, North Africa and Oriental region.

Genus *Graptodytes* Seidlitz, 1887

G. bilineatus (Sturm, 1835) (= *Hydroporus nigritarsis* Sahlberg, 1882)

Examined material: 12.05.1929, Bac river, Chisinau (E. Miller); 05.07.1931, 12.07.1931, 2 ex., Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:135.

Distribution: East Palearctic and Near East.

Genus *Hyphydrus* Illiger, 1802

H. ovatus (Linnaeus, 1761)

Examined material: 16.05.1927, 1 ex., Bularda (A. Ruscinsky).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic and Near East.

Subfamily Laccophilinae Gistel, 1848

Genus *Laccophilus* Leach, 1815

L. minutus (Linnaeus, 1758)

Examined material: 11.07.1905, Voinova (E. Miller, N. Zubovskiy); 05.07.1931, 21.07.1932, 28.07.1932, Bularda (A. Ruscinsky); Voinova, (S. Medvedev, D. Shapiro); 16.12.2013, 2 ex., Braniște (O. Munjiu).

Published records: Miller, Zubovskiy, 1917:123; Ruscinsky, 1934:134; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and Oriental region.

L. hyalinus (De Geer, 1774)

Examined material: 16.12.2013, 3 ex., Braniște (O. Munjiu).

Published records: Yaroshenko, 1957:159.

Distribution: East Palearctic, Near East and North Africa.

L. poecilus Klug, 1834

Examined material: 05.07.1931, 21.07.1932, 28.07.1932, Bularda (A. Ruscinsky); 07.06.1987, 1 ex., Giurgiulesti, 30.06.1987, 1 ex., Giurgiulesti, 01.07.1987, 1 ex., Giurgiulesti, 02.07-03.07.1987, 1 ex., Giurgiulesti, 03.07-04.07.1987, 1 ex., Giurgiulesti, 05.07-06.07.1987, 1 ex., Giurgiulesti, 15.07-16.07.1987, 1 ex., Giurgiulesti, 19.07-20.07.1987, 1 ex., Giurgiulesti, 03.08.1987, 1 ex., Giurgiulesti, 28.09.1987, 1 ex., Giurgiulesti (V. Ostafichuk).

Published records: Ruscinsky, 1934:134.

Distribution: East Palearctic, Near East and North Africa.

Family HYDROPHILIDAE Latreille, 1802

Subfamily Hydrophilinae Latreille, 1802

Genus *Helophorus* Fabricius, 1775

H. aquaticus Linnaeus, 1758

Examined material: 14.02.1900, 27.03.1900, 19.04.1900, 30.09.1900, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

Subgenus *Rhopalohelophorus* Kuwert 1886

H. (Rhopalohelophorus) granularis (Linnaeus, 1761)

Examined material: 05.03–27.03.1917, Chisinau, 27.06.1917, Tighina (E. Miller, N. Zubovskiy); Chisinau, Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic.

Genus *Berosus* Leach, 1817

B. signaticollis Charpentier, 1825

Examined material: 07.04–13.05.1917, Chisinau, 27.06.1917, 01.07.1917, Tighina (E. Miller, N. Zubovskiy); Chisinau, Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917; Medvedev, Shapiro, 1957; Bacal, Munteanu, Toderas, 2013.

Distribution: East Palearctic, Near East and North Africa.

B. spinosus (Steven 1808)

Examined material: Telita (Z. Neculiseanu).

Published records: Neculiseanu et al., 2003:42.

Distribution: East Palearctic and Near East.

Genus *Cercyon* Leach, 1817

C. convexiusculus Stephens, 1829

Examined material: 27.06.1904, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

C. marinus Thomson, 1853

Examined material: 15.08.1907, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and Nearctic region.

C. quisquilius (Linnaeus, 1760)

Examined material: 18.07.1904, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: Australian region, East Palearctic, Near East, Nearctic region, Neotropical region and North Africa.

C. unipunctatus (Linnaeus, 1758)

Examined material: 13.04.1903, Orhei (E. Miller, N. Zubovskiy); Orhei (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic, Near East and Nearctic region.

Genus *Coelostoma* Brulle, 1835

C. orbiculare (Fabricius, 1775)

Examined material: 27.06.1904, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: East Palearctic and Near East.

Genus *Cryptopleurum* Mulsant, 1844

C. minutum (Fabricius, 1775)

Examined material: 04.07.1902, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:421.

Distribution: Near East and Nearctic region.

Genus *Cymbiodyta* Bedel, 1881

C. marginella (Fabricius, 1792)

Examined material: 04.08.1904, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic and Near East.

Genus *Enochrus* Thomson, 1859

E. affinis (Thunberg, 1794)

Examined material: 27.06.1917, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic.

E. bicolor (Fabricius, 1792)

Examined material: 23.06.1917, 08.07.1917, Tighina (E. Miller, N. Zubovskiy); Tighina (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic, Near East and North Africa.

E. quadripunctatus (Herbst, 1797)

Examined material: 05-06.07.1987, 2 ex., Giurgiulesti, 07.06.1987, 1 ex., Giurgiulesti, 09.08.1987, 3 ex., Giurgiulesti, 12.08.1987, 1 ex., Giurgiulesti (V. Ostafichuk).

Published records: new records

Distribution: Europe.

E. nigritus (Sharp, 1872)

Examined material: 27.03.1906, Chisinau (E. Miller, N. Zubovskiy).

Published records: Miller, Zubovskiy, 1917:126.

Distribution: Near East and North Africa.

Genus *Helochares* Mulsant, 1844

H. lividus (Forster, 1771)

Examined material: 27.03.1906, Chisinau, (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: Europe and North Africa.

Genus *Hydrobius* Leach, 1815

H. fuscipes (Linnaeus, 1758)

Examined material: 13.04.1917, 23.06.1917, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic, Near East and Oriental region.

Genus *Hydrophilus* Geoffroy, 1762

H. piceus (Linnaeus, 1758)

Examined material: 04.09.1902, Chisinau, 16.05.1908, Vadul lui Voda (E. Miller, N. Zubovskiy); Chisinau, Vadul lui Voda (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Neculiseanu et al., 2003: 42; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic, Near East and Oriental region.

Genus *Hydrochara* Berthold 1827

H. caraboides (Linnaeus, 1758)

Examined material: 23.06.1906, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro); 05.07-06.07.1987, 2 ex., Giurgiulesti; 23.07.1987, 1 ex., Giurgiulesti (V. Ostafichuk).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Neculiseanu et al., 2003: 42; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic and Near East.

H. flavipes Steven, 1808

Examined material: 23.04.1917, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Neculiseanu et al., 2003: 42; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic, Near East and Oriental region.

Genus *Laccobius* Erichson, 1837

L. bipunctatus (Fabricius 1775)

Examined material: 17.04.1901, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:126; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: East Palearctic, Near East and North Africa.

Genus *Sphaeridium* Fabricius, 1775

Sph. bipustulatum Fabricius, 1781

Examined material: 08.04.1917, Chisinau (E. Miller, N. Zubovskiy); Chisinau (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: Near East and North Africa.

Sph. scarabaeoides Linnaeus, 1758

Examined material: 08.06.1917, Chisinau, 16.05.1917, Vadul lui Voda (E. Miller, N. Zubovskiy); Chisinau, Vadul lui Voda (S. Medvedev, D. Shapiro).

Published records: Miller, Zubovskiy, 1917:127; Medvedev, Shapiro, 1957:189; Bacal, Munteanu, Toderas, 2013:422.

Distribution: Afro-tropical region, East Palearctic Near East, Nearctic region and North Africa.

Genus *Limnoxenus* Motschulsky 1853

L. niger (Gmelin, 1790)

Examined material: 07.06.1987, 1 ex., Giurgiulesti, 22.07.1987, 1 ex., Giurgiulesti, 06.08.1987, 1 ex., Giurgiulesti, 9.08.1987, 1 ex., Giurgiulesti, 12.08.1987, 1 ex., Giurgiulesti (V. Ostafichuk).

Published records: new record

Distribution: Near East.

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FAUNA COLEOPTERELOR ACVATICE (COLEOPTERA: GYRINIDAE, HALIPLIDAE, NOTERIDAE, DYTISCIDAE ȘI HYDROPHILIDAE) DIN REPUBLICA MOLDOVA
(Rezumat)

Lucrarea prezintă lista speciilor de coleoptere acvatice din familiile Gyrinidae, Halipidae, Noteridae, Dytiscidae și Hydrophilidae de pe teritoriul Republicii Moldova. În total sunt cunoscute 59 specii din 35 genuri și 9 subfamilii. Lista a fost elaborată pe baza datelor furnizate de literatura de specialitate, de colecțiile muzeistice, precum și de colectările efectuate de autori.

ASPECTS REGARDING FAUNA FROM GRĂDIȘTEA MUNCELULUI CIOCLOVINA NATURAL PARK

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Abstract: The park staff goes in the territory such that to minimize disruption on a fixed route. The movement begins on predetermined routes until they notice the first sign of mammal. The best time of monitoring is immediately after snowfall. All traces of mammals observed over a distance of 5 m on both sides of the center line transects will be investigated to determine the species to which they belong. If the snow layer is thick the ungulates are concentrated in feeding areas, usually in valleys, called “focus points” that may be considered in monitoring. The fauna from PNGM-C is less studied. Entomofauna is varied and quite rich in the park because the park area is characterized by geographically and geological diversity; here you can find: forests, hills and valleys of rivers, temporary ponds, secondary sylvosteppe grasslands, limestone and sandy areas etc. The most numerous species of insects are in the Grădiște Godeanu Valley. So far the study of invertebrate fauna was limited mainly on butterflies, beetles and orthopterans. The most known groups are vertebrates, reptiles and amphibians. So far in the park area has been identified 18 species of orthopterans belonging to 8 families. The aquatic fauna is represented by a relatively large number of invertebrates and fish. The researches were conducted in collaboration with Lucian Blaga University of Sibiu. From the last category we mentioned: *Salmo trutta*, *Thymallus thymallus*, *Leuciscus leuciscus*, *Cottus gobio* and *Phoxinus phoxinus*. The studies on herpetofauna conducted by researcher Ghira in 2004, and in 2014–2015 by biologist and team of rangers from PNGMC were identified 9 species of amphibians and 11 species of reptiles. Their habitats are clearings of oak forests, sunny meadows, rocks, old walls and cliffs, roadsides and railroads, sunny rocky slopes. Several species of bats were identified in the caves from the park area: *Nyctalus noctula*, *Pipistrellus pipistrellus*, *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros*, *Myotis myotis*. The most important habitats for birds are pure and mixed beech forests. In these forests we find significant populations of birds listed in Annex I of Habitats Directive 79/409/EEC.

There are identified 3 species of mammals of priority interest and 7 species of hunting and community interest.

Keywords: fauna, monitoring, Grădiștea Muncelului-Cioclovina Natural Park

Introduction

Because of the biogeographic, biological and climatic elements Grădiștea Muncelului Cioclovina Natural Park has a very rich and interesting fauna. Here can meet numerous species of great scientific value, some unique in the country or even in the world. The area is excelling in insect diversity.

The Grădiștea Muncelului-Cioclovina Natural Park overlaps two Natura 2000 sites, with temporary regime of special areas of conservation.

ROSPA0045, bird protection area with a surface of 38060 ha, declared by HG no. 1284/2007 declaring Special Protection Areas as part of the European ecological network Natura 2000 in Romania.

ROSCI0087, site of Community importance with an area of 39818 ha endorsed by OM no. 1964/2007 regarding the creation of the protected area of sites of Community importance. The site presents community importance because of the existence of numerous habitats (15), mammals (10 species), amphibians (2 species), 9 species of invertebrates (* *Austropotamobius torrentium*, * *Callimorpha quatripunctaria*, *Eriogaster catax*, *Euphydrys aurinia*, *Gortyna borelii lunata*, *Lycaena dispar*, *Pilemia tigrina*, *Rosalia alpina*, *Osmoderma eremita*), four species of fish species and two plant species.

Material and methods

The wildlife monitoring methods used are:

1. For the inventory and monitoring of entomofauna Barber traps and entomological net were installed on transects established in the Work Plan.

2. The best period to monitoring amphibians and reptiles is the spring. The frequency of observation for reptiles is almost double to amphibian, whose distribution is limited in wetlands or in their vicinity. The richest and most visited areas of the park for reptiles are rocky habitats, meadows, thickets, clumps of forest.

The snakes monitoring was carried out in selected areas based on previous observation (karst areas, rocky habitats, Ponorici-Cioclovina, Red Stone, Godeanu Bulzu, Crivadia, Boli Cave, Tecuri). The observations were done in sunny day, morning to noon on well defined areas around 100–200 square meters, where are animals. For observations, the stones will rise and the reptiles will be photographed and counted individuals and after that the stones are put in place.

The monitoring of amphibians is made easy in the spring season, when the migration occurs at breeding sites, where it accumulates a larger number of individuals. Monitoring is performed in three ways: acoustic (counting the males croak), egg masses counting (especially the *Rana* species, that had circular or oblong egg masses) and direct observation.

3. The monitoring of birds was performed by the method of fixed points and transects (direct observation) in places that were organized transects (Ohaba Ponor-Ponorici, Strei Valley, Bulzu, Lola, Costești, Tâmpu, Godenu).

Species of amphibians, reptiles and mammals were monitored during the birds monitoring.

4. For large mammals: transects, footprints in the snow / soil, feces and direct observation. Transects were established across the main habitats. The transects were established so a route can be covered in a day's work (about 7 km per day). The start and the end of the observation areas are defined according to the known habitat for carnivores. Each transect is observed in winter (three times at intervals of at least one week and after snowfall). Every year are traveled the same routes. The park staff goes in the territory such that to minimize disruption on a fixed route. The movement begins on predetermined routes until they notice the first sign of mammal. The best time of monitoring is immediately after snowfall. All traces of mammals observed over a distance of 5 m on both sides of the center line transects will be investigated to determine the species to which they belong. If the snow layer is thick the ungulates are concentrated in feeding areas, usually in valleys, called "focus points" that may be considered in monitoring.

Results and discussions

The fauna from PNGM-C is less studied. Entomofauna is varied and quite rich in the park because of the geographical and geological diversity of area. In the park area can meet forests, hills and valleys of rivers, temporary ponds, secondary sylvosteppe grasslands, limestone and sandy areas etc. In the Grădiştea Godeanu Valley are the most numerous species of insects. So far the study of invertebrate fauna was limited mainly on butterflies, beetles and orthopterans. The most known groups are vertebrates, reptiles, amphibians and bats. According to previous studies (Burnaz, 1987, 1993, Ghira, 1994, 2002, etc.) in the park were registered 114 species from Lepidoptera, mentioned in Park Management Plan. Out of these 29 species belong to diurnal butterflies (*Rhopalocera*), and 85 species of nocturnal (*Heterocera*). Among the diurnal species some taxa (*Neptis hylas*) are less spread in our country. These taxa is strictly protected species of national interest by Government Emergency Ordinance no. 57/2007. Diurnal lepidopters from this protected area belongs to different ecological types: euribionts like *Vanessa atalanta*, mesophilous and mesohygrophilous from forest (*Hipparchia fagi*) and species that prefer open habitats such as mesoxerophilous and mesohygrophilous grasslands *Lycaena virgaureae*, *Pyronia tithonus*. The macrolepidopters and microlepidopters represent more than 1000 species.

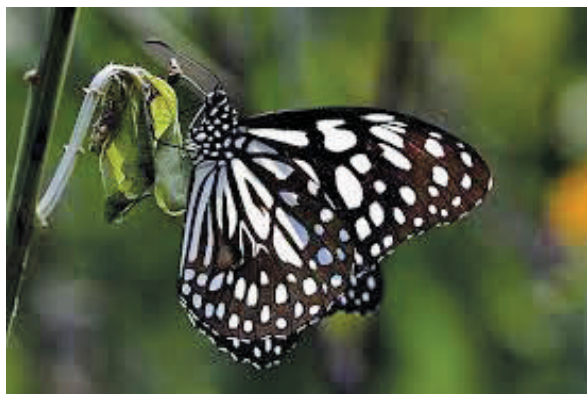


Photo 1: *Neptis hylas*



Photo 2: *Lycaena virgaureae*

Three species of beetles are distinguished by their importance: *Sophnochaeta dacica* (endemic species identified in Tecuri Cave, *Duvalius budai* (rare species identified in Ponor Cave) and *Procerus gigas* (the largest cockroach in Romania, identified in Grădiştea Muncelului). A study conducted by a multidisciplinary team of French researchers together with the team of rangers and biologists of the park, established in Tâmpu and Grădiştea natural forests, the presence of 45 species of saproxilic beetles, belonging to 18 families, located on dead wood. Three species are indicators of naturalness, continuity and maturity of these ecosystems (*Endomychus thoracicus*, *Ceruchus chrysomelinus* and *Triphyllus bicolor*).

So far in the park area has been identified 18 species of orthopterans belonging to 8 families. The aquatic fauna is represented by a relatively large number of invertebrates and fish the researches being conducted in collaboration with Lucian Blaga University of Sibiu. From the last category we mentioned: *Salmo trutta*, *Thymallus thymallus*, *Leuciscus leuciscus*, *Cottus gobio* and *Phoxinus phoxinus*.

The studies on herpetofauna conducted by Ghira I. in 2004, and by biologist and team of rangers from PNGMC in 2014–2015, identified 9 species of amphibians and 11 species of reptiles.

All amphibians identified are strictly protected, six of which are species of community interest and 3 species of national interest by the Emergency Government Ordinance no. 57/2007.

Also *Triturus cristatus*, *Bombina variegata*, *Hyla arborea*, *Bufo viridis* and *Rana dalmatina* are mentioned in Berne Convention, Habitats Directive 92/43/EEC. *Triturus vulgaris* ssp. *ampelensis* has been identified too.

Among reptiles, *Elaphe longissima* is mentioned in the Red List of reptiles in Europe, being subject of strictly protection through the ordinance, the Convention and the directive mentioned above. It should be noted that 9 species of reptiles identified in the park are strictly protected, 7 being species of community interest and two of them of national interest in accordance with Government Emergency Ordinance no. 57/2007. We noticed the reduction of number of amphibians because of degradation of air quality. Their skin is vulnerable to human activities in aquatic and terrestrial ecosystems.

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Photo 3: *Austropotamobius torrentium*

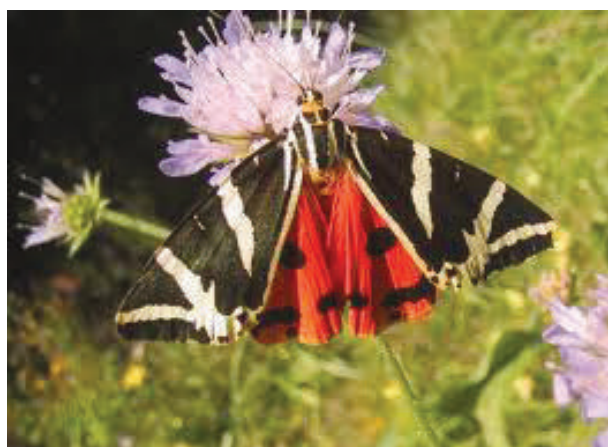


Photo 4: *Callimorpha quatripunctaria*

Parnassius mnemosyne is another species of butterflies, strictly protected by the Habitats Directive – Annex IV, the Berne Convention – Annex 2 and OUG 57/2007 – Annex 4A that lives in grassland habitats and forest litter.

Natrix natrix and *Lacerta* sin. *Zootoca vivipara* are not protected by Romanian legislation instead are listed in Annex III of the Bern Convention. The vulnerable species, *Coronella austriaca*, is included in the Red Book of Vertebrates from Romania, Bern Convention, Habitats Directive (Appendix 4).

Another vulnerable species is *Anguis fragilis* strictly protected by OUG 57/2007 – Appendix 4B and Red Book of Vertebrates from Romania.



Photo 5: *Rosalia alpina*



Photo 6: *Morimus funereus*

Vipera ammodytes is monitored annually; the conservation status is good, natural habitats gives favorable conditions for its survival. It is mentioned in Habitats Directive – Annex IV, Bern Convention – Annex 2, OUG 57/2007 – Annex 4A, Red Book of Vertebrates from Romania, The species of *Lacerta* (*Lacerta viridis*, *L. agilis*, *L. vivipara*) and *Podarcis muralis* are protected by Habitats Directive – Annex IV, Bern Convention – Annex 2, Bern Convention – Annex 3, OUG 57/2007 – Annex 4A. These species are spread almost throughout the park area.

Salamandra salamandra has the official status of endangered species protected by OUG 57/2007 – Appendix 4B, Red Book of Vertebrates from Romania. It is monitored annually, being identified and located in Anineșu, Ohaba Ponor, Tâmpu, Ursoaia.

Their habitats are clearings of oak forests, sunny meadows, rocks, old walls and cliffs, roadsides and railroads, sunny rocky slopes. Several species of bats were identified in the caves from the park area: *Nyctalus noctula*, *Pipistrellus pipistrellus*, *Rhinolophus ferrumequinum*, *Rhinolophus hipposideros*, *Myotis myotis*. The last 3 species requires the designation of special areas of conservation. Sura Mare Cave housed in the years 1960–1970 one of the largest hibernating colonies in Europe, totaling more than 100,000 individuals of *Miniopterus schreibersii* and *Pipistrellus pipistrellus*. Recently, researches in this cave revealed the presence of a large population of bats around 90,000 individuals in hibernation. The dominant species are: *P. pygmaeus* and *Pipistrellus pipistrellus* approx. 34,000 individuals; *Miniopterus schreibersii* 3500 individuals; *Rhinolophus ferrumequinum* approx. 600 individuals; *Nyctalus noctula* over 1000 individuals; *Myotis* spp. approx. 2000 individuals; *Myotis myotis* / *M. blythii* approx. 170 individuals and numerous individuals of *Barbastellus barbastella* in the fissures of rocks.



Photo 7: *Myotis myotis* (photo Gherman L.)

The most important habitats for birds are pure and mixed beech forests. In these forests we find significant populations of birds listed in Annex I of Habitats Directive 79/409/EEC: *Aquila pomarina*, *Circaetus gallicus*, *Pernis apivorus*, *Bonasa bonasia*, *Crex crex*, *Bubo bubo*, *Aegolius funereus*, *Glaucidium passerinum*, *Strix uralensis*, *Caprimulgus europaeus*, *Picus canus*, *Dendrocopus leucotos*, *Dendrocopus medius*, *Dryocopus martius*, *Ficedula albicollis*, *F. parva*, *Lanius collurio*, *Lullula arborea*, *Tetrao urogallus*.



Photo 8: *Dendrocopus leucotos*



Photo 9: *Bonasa bonasia*

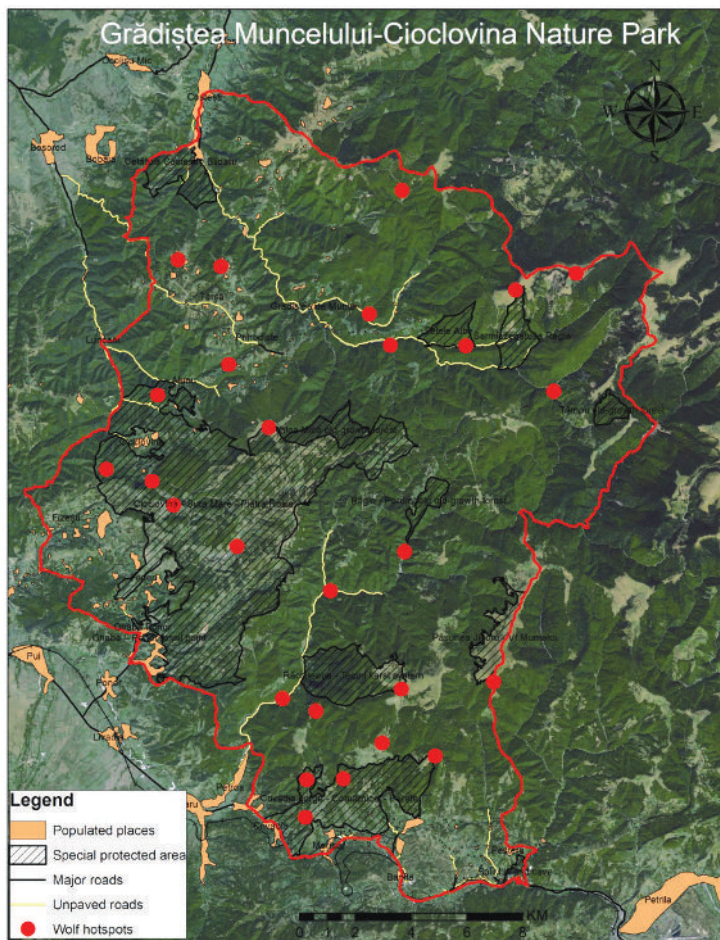


Fig. 1: The map of wolf distribution in park area

There are identified 3 species of mammals of priority interest (bear, wolf laughter – *Canis lupus*, *Ursus artos*, *Lynx lynx*) and 7 species of hunting and community interest (deer, wild boar, fox, badger, marten, wild cat – *Felis silvestris*, *Cervus elaphus*, *Capreolus capreolus*, *Martes martes* etc.).



Photo 10: Reptiles monitoring



Photo 11: Ponoare crab monitoring

Conclusions

The species of fauna are very vulnerable and are constantly under anthropogenic (human) pressure. Therefore management measures for all species of community interest are required.

• Amphibians

- Maintaining the existing aquatic habitat and creating new habitats.
- Ensuring dispersion corridors to keep viable populations.

• Birds

– Regulating the forestall exploitation to ensure optimal conditions of living of all bird populations.

- Limiting the cutting of shrubs from the edge of forests or agricultural lands.
- Maintaining the old, dry trees or ongoing degradation in forest.

• Mammals:

- Hunting regulation of priority species (bear, wolf, lynx).
- Avoiding disruption of silence for mammals.
- Prohibition of removal from habitat of young individuals.
- Control of poaching.
- Avoiding the fragmentation of habitats.
- Limitation of forestry works / other human activities in areas favorable for wolves

raising

- Limitation of human activities in the area of dens.
- **Ponoare crab:**
 - Prohibition of land filling near the watercourses.
 - Prohibition of discharge of wastewater into watercourses.
 - Prohibition of hydro-technical facilities and excavation of any kind in riverbeds.
 - Keeping the woody vegetation near riverbanks.
 - Limiting the catchment from upper areas of rivers.
 - Limiting the works for torrents recovery.

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ASPECTE PRIVIND FAUNA DIN PARCUL NATURAL GRĂDIȘTEA MUNCELULUI CIOCLOVINA (Rezumat)

Fauna din PNGM-C este mai puțin studiată. Până în prezent studiul faunei nevertebratelor s-a rezumat în principal la studiul lepidopterelor, coleopterelor și al ortopterelor; dintre vertebrate, reptilele, amfibienii și chiropterele sunt grupurile cele mai cunoscute. Conform studiilor întreprinse de diferiți cercetători (Burnaz, 1987, 1993, Ghira, 1994, 2002, etc.) au fost înregistrate 114 specii de lepidoptere, înscrise în Planul de Managementul al parcului, dintre care 29 aparțin fluturilor diurni, *Rhopalocera*, și 85 celor nocturni, *Heterocera*. Până în prezent, în perimetrul parcului a fost identificate un număr de 18 specii de ortoptere, aparținând la 8 familii. Fauna acvatică este reprezentată printr-un număr relativ mare de nevertebrate și pești, cercetările fiind efectuate în colaborare cu Universitatea Lucian Blaga din Sibiu. Din ultima categorie amintim: păstrăvul – *Salmo trutta*, lipanul – *Thymallus thymallus*, cleanul – *Leuciscus leuciscus*, zglăvoaca – *Cottus gobio* și boișteanul – *Phoxinus phoxinus*. În urma studiilor consacrate herpetofaunei, efectuate de cercetătorul Ghira în anul 2004 și în 2014–2015, de biologul și echipa de rangeri din cadrul APNGMC, în perimetrul parcului au fost identificate 9 specii de amfibieni și 11 specii de reptile. Toate speciile de amfibieni identificate sunt strict protejate, 6 dintre ele fiind specii de interes comunitar, iar restul de 3 specii de interes național, potrivit Ordonanței de urgență a Guvernului nr. 57/2007, cu modificările și completările ulterioare. De asemenea, *Triturus cristatus* – tritonul cu creastă, *Bombina variegata* – buhaiul de baltă cu burta galbenă, *Hyla arborea* – brotăcelul, *Bufo viridis* – broasca răioasă verde, precum și *Rana dalmatina* – broasca brună de pădure, sunt trecute pe lista speciilor strict protejate ale Convenției de la Berna, respectiv a Directivei 92/43/EEC. Dintre reptile, șarpele lui Esculap – *Elaphe longissima* este trecut pe lista roșie a reptilelor din Europa, beneficiind de altfel de o protecție strictă prin intermediul ordonanței, convenției și directivei mai sus amintite. Este de menționat faptul că 9 dintre speciile de reptile identificate în parc sunt strict protejate, 7 fiind specii de interes

comunitar și 2 de interes național în conformitate cu prevederile Ordonanței de urgență a Guvernului nr. 57/2007, cu modificările și completările ulterioare.

Parcul Natural Grădiștea Muncelului-Cioclovina se suprapune peste 2 situri Natura 2000, cu regim provizoriu de arii speciale de conservare: ROSPA0045, arie de protecție specială avifaunistică cu o suprafață de 38.060 ha, declarată prin H.G. nr. 1284/2007 privind declararea ariilor de protecție specială avifaunistică, ca parte integrantă a rețelei ecologice europene Natura 2000 în România și ROSCI0087, sit de importanță comunitară cu o suprafață de 39.818 ha, declarat prin O.M. nr. 1964/2007 privind instituirea regimului de arie naturală protejată a siturilor de importanță comunitară. Situl prezintă importanță comunitară datorită existenței a numeroase habitate (15), specii de mamifere (10), amfibieni (2), 9 specii de nevertebrate: **Austropotamobius torrentium* – racul de Ponoare, **Callimorpha quatripunctaria*, *Eriogaster catax*, *Euphydryas aurinia*, *Gortyna borelii lunata*, *Lycaena dispar*, *Pilemia tigrina*, *Rosalia alpina*, *Osmoderma eremita*; 4 specii de pești și 2 specii de plante. Speciile de faună prezintă o vulnerabilitate deosebită și sunt constant supuse presiunilor, în special a celor antropice. De aceea este necesar și se impun măsuri de management pentru toate speciile de interes comunitar.

Pentru mamiferele mari:

- reglementarea vânătorii speciilor prioritare: urs, lup, râs;
- evitarea perturbării liniștii pentru speciile de mamifere;
- interzicerea scoaterii din habitat a puilor;
- combaterea braconajului;
- evitarea fragmentării habitatelor;
- limitarea lucrărilor forestiere / altor activități umane în principalele zone favorabile lupilor pentru perioada de creștere a puilor;

- limitarea activităților umane în zona bârlogurilor.

Racul de Ponoare

- interzicerea depozitării deșeurilor de orice natură în apropierea cursurilor de apă;
- interzicerea deversării apelor uzate în cursurile de apă;
- interzicerea amenajărilor hidrotehnice și excavărilor de orice natură în albiile râurilor;
- menținerea vegetației lemnoase din apropierea malurilor;
- limitarea captărilor din zonele superioare ale râurilor;
- limitarea lucrărilor pentru redresarea torenților.

Amfibieni

Conservarea acestor specii necesită măsuri simple, limitate la menținerea habitatelor acvatice existente și crearea de noi habitate, acolo unde este cazul. De asemenea, asigurarea de coridoare de dispersie va permite menținerea unor populații viabile.

THE MESSAGE BEYOND THE FORMS AND COLOURS OF THE TROPICAL BUTTERFLIES. A STUDY OF TROPICAL BUTTERFLIES FROM THE COLLECTION OF THE NATIONAL COLLEGE “ALEXANDRU PAPIU ILARIAN” FROM TÎRGU MUREȘ

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Abstract: The purpose of the current study is to further our knowledge about the influence of the shape and colour of the wings on the process of accommodation to specific environmental conditions.

A taxonomic list of the tropical butterflies from the collection of the school was made at the beginning of the research. The list includes a total of 34 diurnal butterflies and 14 nocturnal butterflies, from 31 different species.

All the species mentioned above were categorised in 4 groups, by one of the following characters:

1. Homochromy – hard to distinguish from the living environment. 2. Vivid colors – the attraction on female. 3. Warning colors – toxicity. 4. The Surprise-Effect – present at nocturnal butterflies, and consisting of the uncovering of the ocelli.

In this study, morphological characters of the wings from various species of butterflies were presented, regarding the representative subjects from each group. Furthermore, the observations which were made accompanied by several information about the living environment and geographical distribution. In order to capture the details of the wings, several photographs of the butterflies from the collection were made.

The observations about the morphology of the wings and the disposition of the colored areas (both macroscopic and microscopic areas) were stored in tables and cyclograms; and showed that each species presents different means to survive in the tropical forest. In order to obtain this results, there was used a microscope with PC connection and protective housing (model Bresser NV Biolux 200x–1280).

After analyzing the collected data, it came out that the toxic butterflies (toxicity caused by the plants which were digested by the larvae) show warning colors. Not only the toxic butterflies show warning color; this characteristic is also present at the species of huge butterflies, the process of mimicry being wide spread. Usually, the male is more colorful than then female and some of the butterflies from the tropical forest show vivid and iridescent colors which make them visible from far away. Another theme studied in our research is the formation of colors, colors which result after the light passes the layers of the scales or due to the process of pigmentation of the scales.

In conclusion, 52% of the species of diurnal butterflies which were studied present sexual dimorphism, the color of the males being more vivid (fact that allows them to find the females); 92% of the species of diurnal butterflies present vivid and warning colors, and just 44% of the total are toxic butterflies. All the toxic butterflies show warning colors. The process of mimicry is being present at almost half of them (48%), allowing them to imitate the toxic butterflies.

Keywords: butterflies, homochromy, ocelli, collection, nocturnal, diurnal

Introduction

The following project includes the results of studying the collection of exotic lepidopteras held by the National College “Alexandru Papiu Ilarian” from Tîrgu Mureş.

The purpose of this investigation was to establish whether the morphology of the wing of butterflies, represented by shape, dimension, as well as the design of the wings, realised in a variation of colours, represents one of the main ways of adapting to life environment.

We advanced the idea that the morphological aspects of the wings, given by shape and polychromy, are not accidental, but in direct correlation with the living environment.

Practically, the wings ensures butterflies: moving by flying with the purpose of finding food and a reproduction partner, respectively, it is the most efficient way of escaping from the predators.

The collection of exotic butterflies of the National College “Alexandru Papiu Ilarian” from Tîrgu Mureş (fig. 1) is composed of 48 specimens, out of which 36 are diurnal and 12 are nocturnal. The butterflies are exposed in 4 varnished cherry wood boxes, the collection being placed in the school, on a wall at the entrance to the Festive Hall, framed by two other boxes of coleopterans. The 4 boxes with glass cover were fixed with screws and dowels, having a good viewing.

Materials and methods

The collection was realised during 2012 and 2013, especially by professor doctor Petru Istrate, after and exchange of coleopterans and lepidopteras from the local fauna, with diverse foreign entomologists.

The collection is duses as didactic material during biology classes for 5th and 9th grade, as well as an attraction for the visitors of the school.

The presentation of the butterfly collection was realised with the occasion of two editions of the exposition “The fascinating world of tropical butterflies”(October 2013, October 2014), with the occasion of the Days of the College-opening of the exposition and communication about the entomological material from the collection, realised by the students of the natural science profile from the National College “Alexandru Papiu Ilarian” from Tîrgu Mureş.

The preparation of the butterflies, which came in transparent wax paper envelopes was realised by taking the well known steps, which began with soaking the butterflies in crystallisers with liquid solution of phenol, poured in successive layers of filter paper. [3,4]

The expansion of the wings was made on some special presses, made out of soft lime, willow or poplar wood, and polystyrene boards.[2]

Drying the exposed butterflies is influenced by more factors. The process takes longer for fresh butterflies and less for the soaked ones. For the bigger species it took 30–45 days, and less for the smaller ones. The drying process was accelerated during summer when the room temperature was kept high and constant.

The butterflies were deposited in special insectariums, with tight seal system, preventing harmful insects from getting inside.

The boxes respect the mandatory standards. They were polished and on each one's bottom surface was fixed a polystyrene board, which enables fixing even the thinnest etymological needles.

Determining the butterflies, which turned out as a challenge, was realised using determination keys and pictures of the butterflies published on specialised websites, for example: <https://www.insectdesigns.com>, butterflycorner.net. Some species came defined.

The faunal list of the lepidopteras from the collection includes (accompanied with information about the etymological material, for example: country, geographic region, to the continent form where the species originates):

Group Rhopalocera (diurnal butterflies)

Fam. Morphidae

- Morpho aega* (South America)
- Morpho achilles amazonicus* (South America)
- Morpho anaxibia* (South America)

Fam. Papilionidae

- Atrophaneura semperi* (Arh. Indonesia)
- Atrophaneura semperi supernotatus* (Arh. Indonesia)
- Ornithoptera croesus* (Arh. Indonesia)
- Ornithoptera goliath* (New Guinea)
- Ornithoptera priamus* (New Guinea)
- Papilio gigon* (Asia SE)
- Papilio memnon* (Asia SE)
- Papilio memnon agenor* (Asia SE)
- Papilio memnon javanensis* (Asia SE)
- Papilio thoas* (Columbia)
- Papilio polytes ledebouria* (Arh. Filipine)
- Papilio ulysses* (Asia SE and Australia)
- Papilio hornimani* (Tanzania)
- Papilio dardanus* (Sub-Saharan Africa)
- Papilio iswaroides* (Asia SE and Australia)
- Trogonoptera brookiana* (Asia SE and Australia)
- Troides haliphron* (Ins. Sulawesi)
- Troides rhadamantus* (Indonezia)
- Troides helena* (Indonezia)

Fam. Pieridae

- Hebomoia glaucippe* (Arh. Indomalaya)

Fam. Brassolidae

- Caligo memnon* (Columbia)

Fam. Nymphalidae

- Idea stolii* (Asia SE)
- Historis odius* (South America)

Group Heterocera (moths)

Fam. Saturniidae

- Antheraea yamamai* (Japan)
- Lobobunaea goodi* (Cameroun)
- Lobobunaea jamensoni* (Cameroun)

Saturnia tyrrhena (Cameroun)

Saturnia vacuna (Cameroun)

Imbrasia truncata (Cameroun)

The colour of the wings fulfils different roles. Only the obvious ones were taken into consideration.

1. Homochromy. The divers coloration is in direct correlation with the environment they live in, meaning in enables them to mix up with the substrate and avoid enemies,(some of the hold their wings up and glued together, looking like a dead leaf, and others like bark).

2. Attracting females and mating (males have brighter colours).

3. Warning enemies that they are poisonous and the must be avoided. *Ornithoptera goliath*, which is the butterfly with the largest scope from the collection , is a poisonous butterfly.

4. Springing a “surprise” and getting rid of the predators. The big ocelli, in bright colours, are characteristic to the posterior wings of nocturant butterflies.

The analysis of the wings of the butterflies was realised in the biology lab of the school, using a didactic stereomicroscope, model Bresser NV Biolux 200x–1280, equipped wit a foot-video camera.

The wing of the butterfly usually has the structure of a leaf, being a complex “veins” structure, which are actually the tracheas of the butterfly, through which air is conducted. The wings are covered in scales, which are seated one next to each other and one after another (fig. 2), intertwined with the scales there are little hairs, which are very abundant at nocturne butterflies, and they cover the butterfly, forming an cover. The hairs can have split ends (fig. 3), especially at nocturnal butterflies. The adaptations serve to flight. Some species have some scales, transparent areas (fig. 4).

The species which have long wings, as most of the ones in the collection, flap their wings and realise long glides – *Ornithoptera goliath*. None of the *Ornithopteras* is attacked by birds! These butterflies are poisonous, and others imitate them, having the same bright colours. The phenomenon is called mimicry.

The species with wide wings move by short outbursts, when they slap the air with force. They flap their wings more rapidly and fly faster.

We wanted to arrange the butterflies after the most viable characteristic their wings present- the drawing, and we found out that the drawing on their wings serve many purposes.

1. Referring to the role that the drawing and the colors on the butterflies’ wings have in identifying with the environment and escaping the predators, especially the insectivorous birds, I have arrived at a series of issues that should be taken into consideration.

Papilio gigon has yellow stripes composed of stains on a brown background situated on the ventral side of the wings, which serve as camouflage against the tree bark. So does *Papilio polytes*, a smaller specie, with a single row of white stains.

Papilio dardanus belongs to the open zones of sub-Saharan Africa. The females lack tails at the posterior wings, which are a male’s characteristic, thus females also display a polymorphism of the wings. (fig. 5). This specie inhabits areas with few trees and sits on open flowers, thin twigs, or different weeds’ stalks, being difficult to identify them due to their cream-coloured wings. Females have the ability to simulate other inedible species’ appearance, a phenomenon called “mimicry” [5].

Papilio ulysses has the superior side of the wings coloured in iridescent blue, with irregular edges, with a bit of black; the ventral side is brown with some lighter ocelli near the edges and some small blue areas (fig. 6). The colours are generated by the microscopic structure of the

scales, phenomenon called structural coloration. Resting on a twig with the wings open makes the butterfly really difficult to be observed. This specie inhabits the tropical forests from the North of Australia, including the Queensland region and northern isles, such as New Guinea, and has the same behaviour as the one of the *Morpho* group, from South America. It can be observed flying from a long distance because of its shiny blue flashes, resembling flags generated by the movement of the wings [6].

Papilio hornimani has got two continuous blue stripes on the superior side of the wings, along with some scattered blue stains. The inferior side of the wings is brown, with very few lighter areas. It possesses the same ability of camouflage like *Papilio ulysses*, and its open wings make it really hard to be detected when resting. It flies in the tall rainforests of Eastern Africa, from Tanzania to the south of Kenya [7].

2. The drawing of the wings helps opposite sex individuals find each other in the tropical forests. The colour of the wings help males attract females for mating.

The intense colours of the wings help the butterflies, both the ones who fly in daylight and the ones who usually fly at night, communicate. The colours allow them to distinguish themselves between other species. Lots of species possess sexual dimorphism, males being different from females, because of their shiny colours which help them attract females. In this case, the specie displays “two forms”. The colours also help with the adjustment of temperature.

The butterflies from the *Morpho* group belong to the Neotropic zone, being usually found in South America, but also in Central America, for instance, in Mexico. The blue colour is broadly encountered and is related to the sexual dimorphism (Fig. 7, 8, 9). At some species (for example: *Morpho adonis*, *Morpho eugenia*, *Morpho aega*, *Morpho cypris* și *Morpho rhetenor*), only the males are of an iridescent blue, while females are brown or yellow. At other species (for instance: *Morpho anaxibia*, *Morpho godarti*, *Morpho didius*, *Morpho amathonte*, și *Morpho deidamia*), the females are partially iridescent, but are more blue than the males. *Morpho* butterflies live in rainforests, from the sea level to 1400 m altitude.

These butterflies are diurnal, the males spend their mornings patrolling river courses through the rainforest. They are territorial and would attack any possible rival. They regularly live alone, except for the mating season.

The flight of this specie is generally wavering, so that they are easily captured. The Indians from South America used the wings of these butterflies to craft ritual masks. Many butterflies from the *Morpho* group have metallic colours, with bright blue or green shadows.

These colours are not the result of pigmentation, but are an example of iridescence caused by the structural coloration: their microscopic scales which cover the wings reflect the light falling down on the successive layers, generating interference effects, which are dependent to both the wavelength and the angle of incidence. Thus, the colours produced vary according to the viewpoint; however, they are surprisingly uniform, probably because of the diamond-shaped (tetrahedral) arrangement of the scales or because of the diffraction at the covering-cells layers. The wide, blue angle of reflection could be explained by the exploitation of the nanostructures from the scales of a *Morpho*'s wing. These three optical, active structures integrate three design principles, leading to a wide angle of reflection. The spectrum of reflection is considered to be large, approximately 90 nm, for the alternating layers and can be controlled by the variation of the design model [8].

The ventral part of the wings is decorated, having printed ocelli or coloured, eye-shaped spots. This phenomenon is called “auto mimicry”. The role of the ocelli is to confuse the possible enemies when the butterfly is resting.

These butterflies are edible, but it is believed that their vivid colours are a form of mimicry, called aposematism, when they imitate toxic species, the colours being a sign of warning. Although, the less intense coloured species are the best flyers, being captured extremely hard, even by the specialized birds.

Morpho achilles amazonicus has the dorsal side of the wings coloured in black, with bright, blue, wide stripes (fig. 7). There are also some white stains on the exterior edges of the wings. The ventral side of the wings is brown-olive with numerous ocelli, composed of blue, yellow, red and red concentric rings.

The kites attack the protruding ocelli from the ventral side of the wings, the body remaining intact.

It is found in the majority of tropical forests from South America [9].

Morpho anaxibia is remarkable for the fact that the males have the superior side of the wings coloured in an intense blue. (fig. 8). The female has a wide, black stripe on the exterior of the blue zone. The inferior side of the wings is brown, with some lighter areas and there is a series of light brown ocelli with a white spot on the interior. Each of the four wings has 5 small ocelli. This butterfly is found in the tropical forests of Brazil [10].

Morpho aega is a butterfly that shows sexual dimorphism, only the superior wings of the male are of an iridescent blue (fig. 9). The anterior wings are brown on the ventral side, with one small ocellus, while the posterior ones are also brown, but with three smaller ocelli.

It lives in the whole South America, Central America and Mexico.

Papilio ulysse is very similar to this species (fig. 10).

Papilio memnon – “the great Mormon” - is found in a variety of forms and subspecies. The analyzed collection presents the *memnon*, *aegenor* and *javanensis* forms.

The ventral side of the wings, especially at the posterior wings, has numerous red stains (fig. 11), which are obvious when the butterfly rests on a flower, or when it is seen from behind. This is a form of mimicry, the butterfly imitates dangerous species, but it is also a signal for the individual of the opposite sex. The females present different forms of polymorphism and mimicry. It is found in the rainforest from South-eastern Asia [11].

Papilio thoas, *Papilio iswaroides* are polychromatic butterflies, the first one with a mimicry behaviour and the second one with a monochromic behaviour.

3. The intense colours of the wings and the body caution the enemies that the butterfly is poisonous.

The butterflies with “birdwings” belong to the Trogonoptera, Troides and Ornithoptera group, each of them from the Papilionidae family. They are called so due to their large wings, with sharp angles, and their flight which resembles the one of the birds. The sexual dimorphism exists only at the Ornithoptera species (fig. 12), where the wings of the male have big black areas, with bright, iridescent green, blue, orange or yellow stains. The females are large and have less intense colours. Their wings are black or dark brown, with white, pale brown or yellow areas.

Ornithoptera priamus, “the birdwing butterfly” is green. The male has the dorsal side of the anterior and posterior wings coloured in black, with green, wide stripes. The ventral side of the anterior wings is black and that of the posterior wings is dark green. Moreover, the females are much larger, having dark brown wings with distilled white stains. The ventral side of the wings is quite alike. There are male individuals in the New Guinea with blue stripes. This butterfly’s behavior resembles the one of the above mentioned specie, the vivid colours helping the individuals find each other in the tropical forest. It inhabits the Indonesian Archipelago, a larger area than the above mentioned specie [1, 13].

Ornithoptera croesus, is a subspecies of the aforementioned species (from many authors' point of view).

The males and the females of the most „birdwings butterfly” species from the *Troides* group are similar, having the anterior wings painted in brown or black, with cream-coloured nervures. The colour of the wings is determined by the pigments, except for *Troides magellanicus*, whose posterior wings have a blue-green iridation, generated by the diffraction of light produced after its reflection [14].

Trogonoptera brookiana is a spectacular species, the wings of the male are black, the dorsal side of the anterior ones having seven tooth-shaped, electric-green stains, and the posterior ones displaying a large, distinctive, green stain. The female's wings have distinctive, white zones on both the anterior and posterior wings, being even darker than the males. It lives in different zones of Malaysia. It is toxic because of aristolochic acid present in the plants that its larva feeds from. It has a determined flight and lives on the peak of the trees, being a good pollinator for the flowers [15].

Historis odius is a butterfly from South America, living in the rainforests and broadleaf forests. The orange wings make it look like a toxic butterfly [16].

Idea stolii is a slow, elegant butterfly, which prefers the crowns of the trees from the rainforest in South-eastern Asia. Its wings are genuine mosaic of white and black stains, the butterfly being very poisonous. It is usually avoided by the birds, the model of the wings being visible due to its slow flight [17].

Hebomoia glaucippe, “the big, orange butterfly”. The anterior wings have, on the dorsal side, a large, triangle-shaped, orange stain. The rest of the wing and the posterior one are white with a few black spots. It does not present dimorphism, the females being very similar to the males. The ventral side of the wings is white, with black spots, forming a drawing used to camouflage. This butterfly is extremely toxic, containing *glacontryphan-M*, a toxic peptide belonging to the contryphan family, found also in a type of snails [17].

Atrophaneura semperi is a butterfly with diminished sexual dimorphism, the males resembling the females. The dorsal wings are black, with a white, inguinal stripe on the posterior wings and numerous red stains on the ventral side. The abdomen and the rest of the body are red. This butterfly is toxic because the plants that its larva feeds from.

The majority of these butterflies is poisonous, having as a warning sign the intense colours, so that they are avoided by birds.

4. The large ocelli from the posterior wings scare the possible enemies, fact called “the surprise effect”.

The nocturnal butterflies are equipped with a very efficient weapon. When disturbed, they generate a “surprise effect” aimed at the attacker, usually the kites, by suddenly discovering their posterior wings, as the effect of the anterior wings moving forward. The posterior wings display a drawing that imitates an animal's head, with two big eyes, intensely coloured (fig. 13). Usually, the attacker hits the fake eye, while the butterfly has the possibility to escape by flight. Hence, the butterflies are hardly observable in daylight, the anterior wings which cover the posterior ones imitate the substratum, phenomenon called “homochromy”.

Lobobunaea goodi is a butterfly of Cameroon provenance, which presents two ocelli, each of one on the back side of the posterior wings and which are usually hidden. The first ring of the ocelli (the exterior one) is yellow, while the second one from the interior is dark, almost black.

Lobobunaea jamesoni aethiops is also a butterfly from Cameroon which has two big ocelli on the back side of the posterior wings, but they are missing on the above wings. The exterior circle is yellow, the middle one is black and the interior one is orange. Their wings are

colored in dark maroon. Their scales are covered with dense and woolly hairs, as all the other butterflies from their family [18].

Saturnia tyrrhena is a huge butterfly which can be seen all over the tropical zone of the African continent. Their fore wings show two triangular zones which do not have scales. Regarding the posterior wings, they both have on their back side one big ocelli that has its exterior ring painted black and the interior one painted blue.

Saturnia vacuna is a butterfly which is called “cobra’s head” due to both their wings’ shape and the drawing that resembles the head of a cobra snake which is displayed on the top of the fore wings. Each wing has an elongated stain on its back side that is actually a deformed ocelli. When the butterfly rests, the fore wings don’t overlap the posterior ones.

Imbrasia truncata has a huge ocelli on the top of their posterior wings, consisting of a ring which is colored in white, orange and dark. This species overlaps its posterior wings when it rests.

Antheraea yamamai is the Japanese *Bombyx mori*. Silk is a material which can hardly be painted but is really flexible and tough. These days, there were some specimens that escaped the farms and their descendants can be found in the oak forests from Central Europe. This species has one ocelli on each wing; however, the ones from the posterior wings are bigger. The wings are painted in dark maroon, while the light maroon tint of the ocelli makes them seem very prominent. There is a great variety of color regarding this species, but the one present in the collection is dark colored. When the butterfly rests, the fore wings don’t overlap the posterior ones.

There are species with very efficient ocelli even from the diurnal butterflies group. Such an example is *Caligo memnon* which is also called “The Giant Owl Butterfly”. On the ventral part of the posterior wings, it has two huge eyes, acknowledging the fact that the hinder ones are bigger and provided with two rings (the external one (black) and the internal one (yellow)), with the middle zone being painted black. On the fore wings, there can be seen two little eyes. The color of their wings is maroon, so they can imitate the tree bark when resting [19].

Results and discussions

Thirty one species of butterflies have been studied, from which 25 are diurnal species and 6 are nocturnal species.

The way in which the scales are situated on the wings (which is the thing that makes the flight possible) was studied with a stereomicroscope provided with a video camera, existent in the biology laboratory. The use of this microscope, which captured the tissues of the butterflies, helped discovering other details about the structure of the wings such as: the existence of the hairs, the form of the ribs – which are responsible for the strength and the flexibility of the wings.

The study of the butterfly collection and the analysis of the photographs, provided for each of the 31 species, the role played by the color of the wings.

After the study of a total of 25 species of diurnal butterflies, the following statements were made (the collected data is displayed in cyclograms and percentages and emphasizes comparatively the morphology, shape and color of the wings):

- 13 species present sexual dimorphism, the color of the male being more intense than the one of the female. It have been observed that the color and the shape of the wings differ depending on sex. The females from some species show a variability in what the shape and the color of the wings are concerned (the presence of polymorphism either among the subjects of the same population). (Cyclogram 1)

– 23 out of the 25 species of butterflies which were studied (meaning 92%), show warning colors, either the butterflies are toxic or not. All the toxic butterflies present in the collection (meaning 11 species) present warning colors. (Cyclogram 2)

– 11 out of the 23 species of diurnal butterflies (44%) are toxic butterflies and present warning colors, while 12 species out of 23 (52%) just immitate the dangerous species (process called aposematism). (Cyclogram 3)

– 12 out of the 25 species of butterflies (44%) show camouflage colors when the butterfly rests and its wings are high and glued together (process called homochromy). (Cyclogram 4). Generally speaking, toxic butterflies don't have camouflage colors, but there are some exceptions such as *Historis oides*.

– The majority of the butterflies show a slow flight due to the huge dimension and surface of their wings. All birdwings butterflies have a slow flight, with the exception of *Trogonoptera brookiana*, whose fore wings form a very acute angle.

– The Surprise-Effect is present at all the nocturnal species, process that consists of the disclosure of the ocelli. The Surprise-Effect is missing at the diurnal species, with the exception of *Caligo Memnon* – “The Giant Owl Butterfly”. (Cyclogram 5)

– The color of the scales depends on the pigment of the butterfly for the majority of the species, with the exceptions of Morpho butterflies (structural type), *Trogonoptera brookiana* and *Papilio ulysses* (both processes). (Cyclogram 6).

The final results were stored in the table 1.

Conclusions

Around 52% of the species of diurnal butterflies which were studied present sexual dimorphism, the color of the males being more vivid (fact that allows them to find the females); 92% of the species of diurnal butterflies present vivid and warning colors, and just 44% of the total are toxic butterflies. All the toxic butterflies show warning colors. The process of mimicry is being present at almost half of them (48%), allowing them to imitate the toxic butterflies.

All this characteristics (warning colors, toxicity, fast flight at some species, camouflage colors and surprise-effect at nocturnal species) allow the species of huge butterflies, like the ones from the collection, both to escape the attack of the insectivorous birds and to find their matching partner. All this characteristics mentioned above helped at the adaptation of the butterflies to the living environment, and also made some of the species evolve to great dimensions, which together with other perfected means of surveillance, made them the second specie of invertebrate animals (after beetles) in what population is concerned.

Table 1: The checklist of studied species

No.	Species	Sexual Dimorphism (regarding color)	Warning Colors	Toxicity	Camouflage Colors	Surprise-Effect (at nocturnal species)	The character of flight (fast/slow)	Color Formation (pigment/structural)
1.	<i>Morpho aega</i>	✓	✓	✗	✓	✗	slow	structural
2.	<i>Morpho anaxibia</i>	✓	✓	✗	✓	✗	slow	structural
3.	<i>Morpho achilles amazonicus</i>	✗	✓	✗	✓	✓	slow	structural
4.	<i>Atrophaneura semperi</i>	✗	✓	✓	✗	✗	slow	pigment

No.	Species	Sexual Dimorphism (regarding color)	Warning Colors	Toxicity	Camouflage Colors	Surprise-Effect (at nocturnal species)	The character of flight (fast/slow)	Color Formation (pigment/structural)
5.	<i>Ornithoptera croesus</i>	✓	✓	✓	✗	✗	slow	pigment
6.	<i>Ornithoptera goliath</i>	✓	✓	✓	✗		slow	pigment
7.	<i>Ornithoptera priamus</i>	✓	✓	✓	✗	✗	slow	pigment
8.	<i>Papilio gigon</i>	✗	✗	✗	✓	✗	slow	pigment
9.	<i>Papilio memnon</i>	✓	✓	✗	✗	✗	slow	pigment
10.	<i>Papilio memnor agenor</i>	✓	✓	✗	✗	✗	slow	pigment
11.	<i>Papilio memnor javanensis</i>	✓	✓	✗	✗	✗	slow	pigment
12.	<i>Papilio thoas</i>	✓	✗	✗	✓	✗	slow	pigment
13.	<i>Papilio polytes ledebouria</i>	✓	✓	✗	✗	✗	slow	pigment
14.	<i>Papilio ulysses</i>	✓	✓	✗	✓	✗	slow	pigment/structural
15.	<i>Papilio hornimani</i>	✗	✓	✗	✓	✗	slow	pigment
16.	<i>Papilio dardanus</i>	✓	✓	✗	✓	✗	slow	pigment
17.	<i>Papilio iswaroides</i>	✗	✓	✗	✓	✗	slow	pigment
18.	<i>Trogonoptera brookiana</i>	✓	✓	✓	✓	✗	fast	structural
19.	<i>Troides haliphron</i>	✗	✓	✓	✗	✗	slow	pigment
20.	<i>Troides rhadamantus</i>	✗	✓	✓	✗	✗	slow	pigment
21.	<i>Troides helena</i>	✗	✓	✓	✗	✗	slow	pigment
22.	<i>Hebomoia glaucippe</i>	✓	✓	✓	✗	✗	fast	pigment
23.	<i>Caligo memnon</i>	✗	✗	✗	✓	✓	slow	pigment
24.	<i>Idea stolii</i>	✗	✓	✓	✗	✗	slow	pigment
25.	<i>Historis odius</i>	✗	✓	✓	✓	✗	fast	pigment
26.	<i>Antheraea yamamai</i>	✗	✗	✗	✓	✓	?	pigment
27.	<i>Lobobunaea goodi</i>	✗	✗	✗	✓	✓	?	pigment
28.	<i>Lobobunaea jamensoni</i>	✗	✗	✗	✓	✓	?	pigment
29.	<i>Saturnia tyrrhena</i>	✗	✗	✗	✓	✓	?	pigment
30.	<i>Saturnia vacuna</i>	✗	✗	✗	✓	✓	?	pigment
31.	<i>Imbrasia truncata</i>	✗	✗	✗	✓	✓	?	pigment

Legend: The ✓ symbol was used to mark the presence of a specific character at one particular specie, while the ✗ symbol was used to mark the absence of the same specific character.

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**MESAJUL FORMELOR ȘI CULORILOR FLUTURILOR TROPICALI. UN
STUDIU AL FLUTURILOR DIN COLECȚIA COLEGIULUI NAȚIONAL
„ALEXANDRU PAPIU ILARIAN” DIN TÎRGU MUREȘ
(Rezumat)**

Lucrarea de față dorește să aducă o contribuție la cunoașterea rolului pe care îl îndeplinesc forma aripilor și culorile acestora în succesul adaptativ al fluturilor la condițiile de mediu.

La începutul desfășurării cercetării propriu-zise, s-a realizat lista taxonomică a speciilor de fluturi tropicali din colecția Colegiului, un număr de 34 exemplare de fluturi de zi și 14 exemplare de fluturi de noapte, aparținând la 31 de specii, folosind diverse website-uri de specialitate.

Aceste specii au fost introduse în 4 grupe, folosind unul dintre criteriile:

1. Homocromia – greu de distins din mediul de viață. 2. Culorile vii – atragerea femelelor. 3. Culorile de avertizare – toxicitate. 4. Efectul surpriză, la fluturii de noapte, când dezvelirea oclilor derutează păsările insectivore.

Au fost prezentate caractere morfologice ale aripilor la mai multe specii de fluturi, reprezentativi pentru fiecare grupă. De asemenea, observațiile au fost însoțite de o serie de informații legate de mediul de viață – habitată, și de răspândirea geografică. Au fost realizate numeroase fotografii originale ale fluturilor din colecție, precum și detalii ale aripilor.

În urma observațiilor macroscopice de morfologie a aripii, dispunere a zonelor colorate și a celor microscopice – utilizând un microscop didactic cu conexiune PC și carcasă de protecție model Bresser NV Biolux 200x–1280, rezultatele au fost cuprinse într-un tabel și în ciclograme, arătând faptul că fiecare specie prezintă mai multe mijloace care le asigură succesul în supraviețuirea în pădurea tropicală.

În urma prelucrării rezultatelor s-a constatat că fluturii toxici (toxicitate datorată plantelor pe care le consumă larvele) prezintă culori de avertizare, dar și fluturii care nu sunt toxici, dar de dimensiuni mari recurg la acest mijloc, mimetismul fiind larg răspândit. Masculii sunt de regulă mai colorați decât femelele, iar unii dintre fluturii din pădurea tropicală prezintă culori vii, irizante, care îi fac vizibili de la mare distanță; formarea culorilor, prin pigmentația solzilor sau prin modul în care traversează lumina straturile din compunerea solzilor, fiind o altă temă abordată în studiul nostru.

În concluzie, 52% dintre speciile de fluturi de zi analizate prezintă dimorfism sexual, culoarea masculilor fiind mai vie, ceea ce le permite găsirea femelelor, 92% prezintă culori de avertizare, culori vii și doar 44% din totalul fluturilor sunt toxici. Toți fluturii toxici au culori de avertizare. Mimetismul este prezent și aici, aproape jumătate, 48% imitând fluturii toxici. Fluturii toxici nu au culori de camuflaj.



Fig. 1: Picture of the collection of butterflies (detail) present the biology laboratory of the college (Photo Petru-Vasile Istrate)

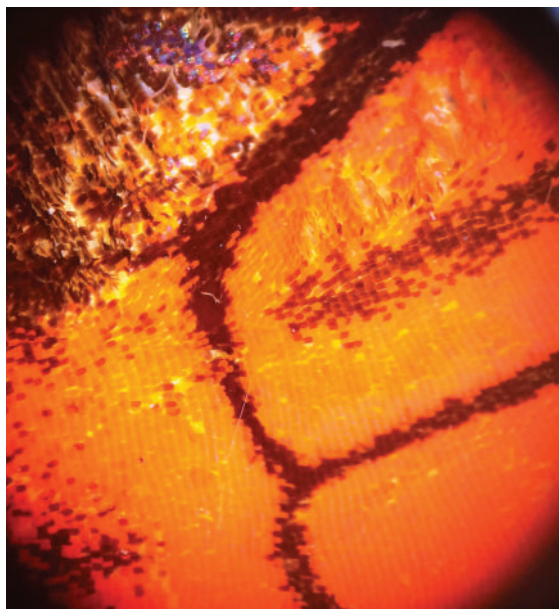


Fig. 2: *Hebomoia glaucippe*. Detailed fore wing – orange and brown scales (Photo Roxana Cosma)



Fig. 3: Detailed wing of a nocturnal butterfly. The scales are doubled by hairs which are branched at the top (Photo Roxana Cosma)

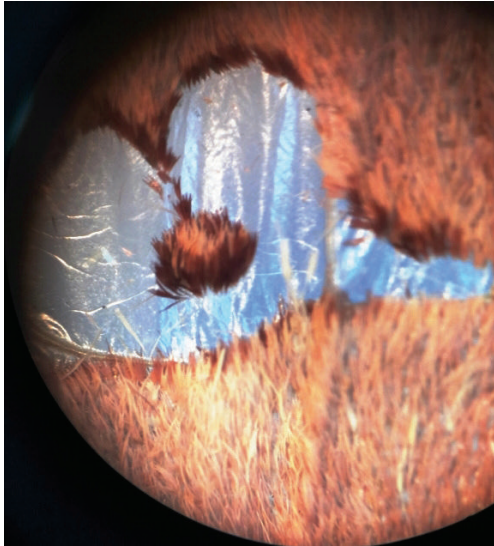


Fig. 4: Scales and hairs which define an area free of scales of a nocturnal butterfly (Photo Roxana Cosma)



Fig. 5: *Papilio dardanus* is a butterfly which can be seen on the african continent (Photo Petru-Vasile Istrate)



Fig. 6: *Papilio ulysses* presents camouflage colors on the ventral side of the wings (Photo Petru-Vasile Istrate)



Fig. 7: *Morpho achilles amazonicus*, the intense color of the male attracts females (Photo Petru-Vasile Istrate)



Fig. 8: *Morpho anaxibia*, coloration with metallic iridescent wings (Photo Petru-Vasile Istrate)



Fig. 9: *Morpho aega*, the intense blue color of the male (Photo Petru-Vasile Istrate)



Fig. 10: *Papilio ulysses*, the intense blue color of the male (Photo Petru-Vasile Istrate)



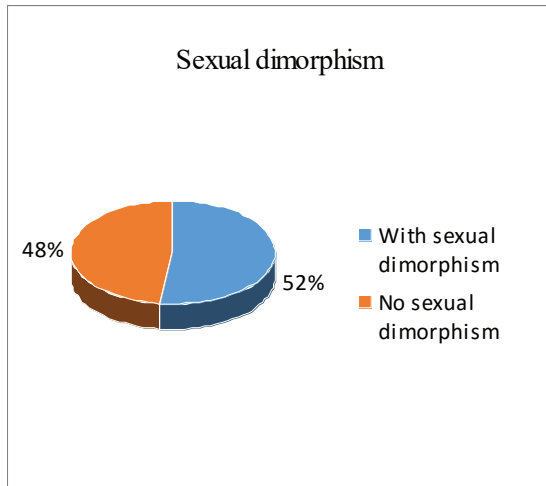
Fig. 11: *Papilio memnon*, exemple of mimicry which regards strong colors



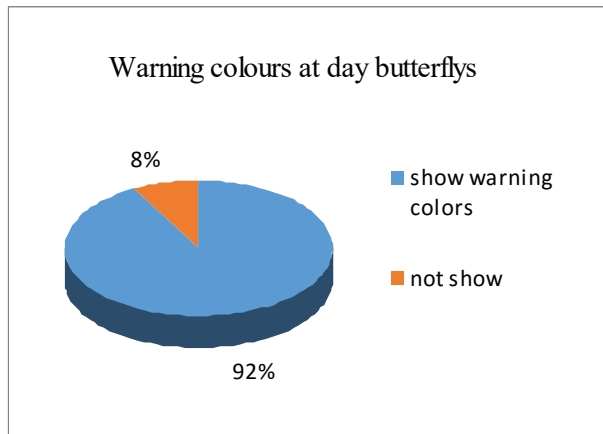
Fig. 12: *Ornithoptera goliath*, *Ornithoptera priamus*, *Trogonoptera brookiana*, *Troides helena* – birdwing butterflies, which present warning colors.



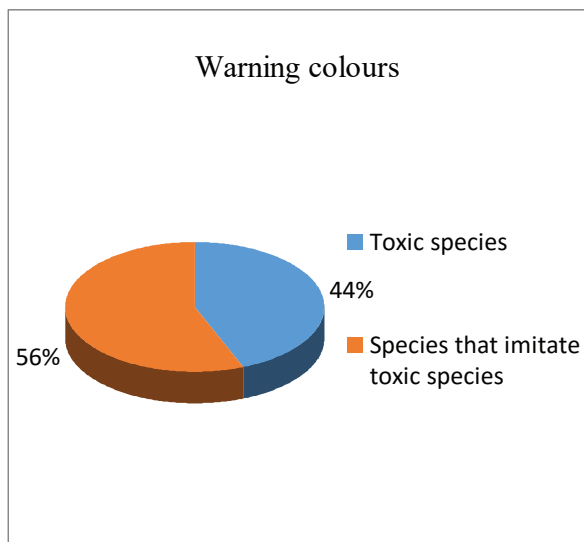
Fig. 13: Different ocelli at nocturnal butterflies and *Caligo memnon* (diurnal butterfly)



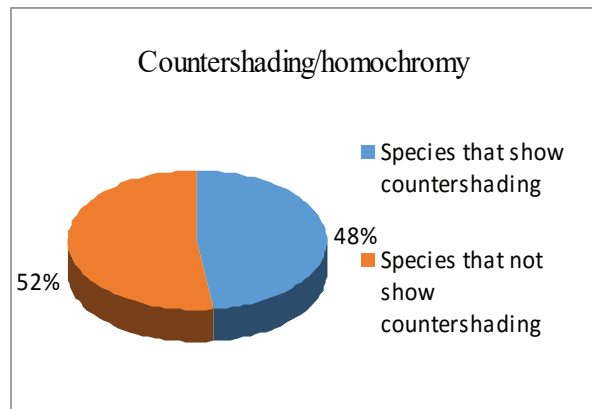
Cyclogram 1: Sexual dimorphism at diurnal butterflies



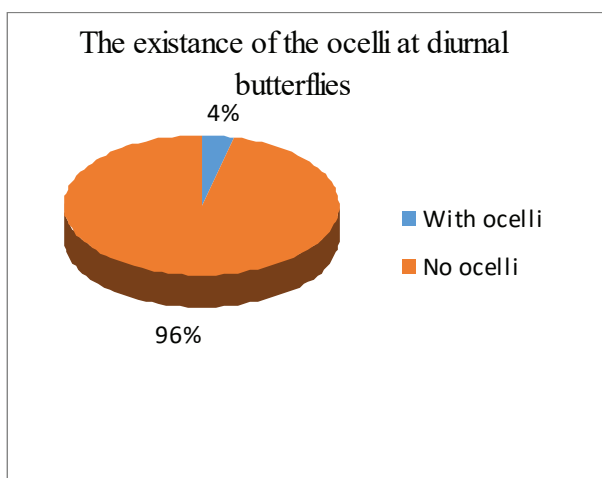
Cyclogram 2: Warning colors at diurnal butterflies



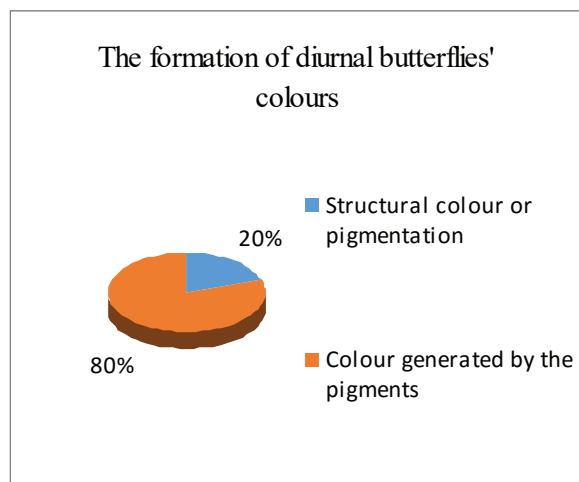
Cyclogram 3: Toxic and non-toxic species/ the existence of the ocelli at diurnal butterflies



Cyclogram 4: Camouflage colors at diurnal butterflies



Cyclogram 5: The surprise-effect, especially at nocturnal butterflies



Cyclogram 6: The formation of the color from the scales

PRESERVING AND PROTECTING CONDITION OF BIRDS SPECIES IDENTIFIED IN CHIȘINĂU

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Abstract: The research was conducted during five years consecutively in all phenological periods. On the territory of municipality Chișinău, were identified 110 species of birds, including: 33 are summarized in the Birds Directive, 101 species in the Berne Convention and 13 species in Bonn Convention, law 1538/1998 refers to 18 species of avifauna identified in Chișinău. The most numerous birds are insectivorous and belong to passeriformes class, these serve as a regulator factor of insect pests. The national legislation, as well as international conventions that Republic of Moldova joined, on the issue of protection of bird species is most often not applicable, the latter lead to decreased diversity and abundance of bird species across the territory of the country.

Keywords: urban ecosystem, preservation, birds, protection measures, legislation.

Introduction

Urban ecosystems are of particular importance for environmental protection and biodiversity conservation, establishing itself as a valuable component in creating ambience between the building blocks and the environment.

In the last decades all around the world it was noticed a strong trend of accommodation in cities of the animals and especially birds, finding favorable biotope for food and reproduction [3, 4]. This situation has accrued due to an alteration of natural habitats, which can not provide optimal conditions for many species of birds. In such conditions the birds are forced to adapt to new living conditions offered by anthropogenic environment, which is not always hospitable for the vast majority of species of wild birds [3]. This is the reason why a specific attention should be given to birds' protection that leave in the anthropic environment, and also to habitats (natural or artificial) where these find optimal living conditions. National legislation seems to meet the protection of green spaces. Thus in Law 591/1999 regarding the green spaces of urban and rural settlements, establishes the relationships between development field and protection of green spaces [6]. In the context of this law it is revealed the purpose and the importance of green spaces, namely:

- a) Green spaces, regardless of belonging and purpose, serve to improve the environment, maintain the ecological balance and local genofond, enrich the assortment of ornamental plants, maintain and protect precious natural objects and harmonizing artificial landscapes with natural ones in order to achieve a favorable ambience for anthropogenic activity.
- b) The importance of green spaces is subject to the following functions:

- improves the environment by reducing pollution and enriching the atmosphere with oxygen

- water conservation, combating soil erosion and landslides;
- noise reduction;
- positive influence on physical and mental health of people;
- harmonizing artificial landscapes with natural ones;
- improves the aesthetic – architectural appearance of the localities;

Ministry of Environment stated that the green areas of Moldova are below European standards. In the European Union the standard of green space per capita is at least 26 m² (square meter), and the recommendations of the World Health Organization suggests a minimum of 50 m² per capita. According to data provided by the Green Areas Management Association from Chişinău, the scarcity of green space per capita is currently low, constituting 16 square meter per capita. The total area of forest land in Chişinău today is about 7648.49 ha (19 % from the total area of the municipality). Urban green spaces occupy about 3623.49 ha (24 % from the total area of the city) [5]. Forest vegetation is represented by deciduous forests like those in Central Europe. It turns that in terms of quantity the green spaces situation in the city is good, less their quality. The diversity of bird species in a biotope is directly proportional with the phytocenotic diversity of this biotope. Thus, the investigation shows that the phytocenotic ratios failure and the small number of hollow trees, leads to a small variety of species of birds especially those insectivorous that prefer closed nests.

Material and methods

Quarterly observations were made in period 2009–2014 in urban and ecosystems with a different level and nature of anthropogenic influence. The following research methods of investigations were used:

- a) transect method; [1]
- b) method of point estimation; [1]
- c) mapping method; [1]
- d) method of photographic recording;

For the research was used the following equipment: binocular Yukon, digital cameras, camcorder, tracking fixed cameras, which were placed on the ground, dictofon, GPS. Equipment for long distance field research includes magnification telescope 1 × 1000, with monocular night vision, digital camera and 500mm lens.

Results and discussions

The fieldwork research was conducted in the municipality Chişinău ecosystems, there were selected for research the most representative areas, namely: forest parks (Izvor Park, Botanical Garden), dawnstawn parks (Rose Valley, Ştefan cel Mare, Dendrariu); natural island forests near the city. The open ecosystems from the surroundings of the city being represented by meadows, fallow, wheat crop, corn, lucerne, vine, orchards, sunflower, gardens, riverain biotops and swamp vegetation undergrowth or hydrophilic.

Concerning the Protection of Birds, each of the identified species in the city Chişinău it is framed in the following lists: SPEC List [2], Europe Council Directive (79/409) in regards to the conservation of wild birds [7], Berne Convention, Bonn Convention [7], Law on Natural Areas Protected by State 1538/1998 [6].

List SPEC (SPEC – Species of European Conservation Concern) includes bird species conservation that is the main object of concern in Europe.

List **SPEC 1** includes worldwide endangered species. A single species that belongs to this list was identified in the city Chişinău, it was met at Botanical Garden during breeding – *Crex crex*.

List **SPEC 2** includes species with unfavorable conservation status in Europe whose global population (more than 50%) is concentrated in Europe. In this list 8 species are found of those presented in Chisinau and namely: *Ciconia ciconia* (species of passage), *Aythya ferina*, *Aquila pomarina*, *Otus scops*, *Phoenicurus phoenicurus*, *Carduelis canabina*, *Miliaria calandra*, *Emberiza hortulana*.

In list **SPEC 3** there are species with unfavorable conservation status in Europe whose global population is not concentrated in Europe. Here fall 22 species identified in Chisinau: *Gavia stellata*, *Nycticorax nycticorax*, *Ixobrychus minutus*, *Perdix perdix*, *Streptopelia turtur*, *Athene noctua*, *Alcedo atthis*, *Merops apiaster*, *Upupa epops*, *Picus canus*, *Jynx torquilla*, *Galerida cristata*, *Alauda arvensis*, *Hirundo rustica*, *Delichon urbica*, *Lanius collurio*, *Anthus campestris*, *Sturnus vulgaris*, *Muscicapa striata*, *Parus palustris*, *Passer domesticus*, *Passer montanus*.

The list **Non SPEC** includes species of birds with favorable conservation status in Europe, whose population is not concentrated in Europe. This category includes 48 species of birds that can be found in Chisinau: *Podiceps cristatus*, *Ardea cinerea*, *Accipiter nisus*, *Accipiter gentilis*, *Buteo buteo*, *Falco subbuteo*, *Phasianus colchicus*, *Gallinula chloropus*, *Fulica atra*, *Streptopelia decaocto*, *Cuculus canorus*, *Asio otus*, *Srix aluco*, *Apus apus*, *Dendrocopos major*, *Dendrocopos minor*, *Anthus trivialis*, *Motacilla alba*, *Motacilla flava*, *Oriolus oriolus*, *Bombycilla garrulus*, *Garrulus glandarius*, *Pica pica*, *Corvus frugilegus*, *Corvus corone cornix*, *Corvus corax*, *Troglodytes troglodytes*, *Acrocephalus arundinaceus*, *Acrocephalus scirpaceus*, *Sylvia curruca*, *Phylloscopus collybita*, *Phylloscopus sibilatrix*, *Phylloscopus trochilus*, *Ficedula parva*, *Saxicola torquata*, *Phoenicurus ochruros*, *Erithacus rubecula*, *Parus major*, *Parus caeruleus*, *Aegialus caudatus*, *Remiz pendulinus*, *Sitta europaea*, *Certhia familiaris*, *Pyrrhula pyrrhula*, *Coccothraustes coccothraustes*, *Carduelis flammea*, *Loxia curvirostra*.

List **Non SPEC E** includes species with a favorable conservation status in Europe whose global population (more than 50%) is concentrated in Europe. 29 the identified species in green areas from Chişinău are to be found in this list: *Cygnus olor*, *Larus ridibundus*, *Larus cachinans*, *Columba palumbus*, *Dendrocopos syriacus*, *Dendrocopos medius*, *Anthus pratensis*, *Corvus monedula*, *Hippoboscus icterina*, *Sylvia atricapilla*, *Sylvia borin*, *Sylvia communis*, *Regulus regulus*, *Hippoboscus icterina*, *Fringilla coelebs*, *Fringilla montifringilla*, *Serinus serinus*, *Carduelis chloris*, *Carduelis spinus*, *Carduelis carduelis*, *Emberiza citrinella*, *Ficedula hypoleuca*, *Ficedula albicollis*, *Luscinia luscinia*, *Turdus iliacus*, *Turdus merula*, *Turdus philomelos*, *Turdus viscivorus*, *Turdus pilaris*.

From those 110 species identified in Chişinău 35 are contained in Birds Directive, Europe Council Directive 79/409 EEC regarding conservation of wild birds adopted on April 2nd 1979 (table 1). Among these, 10 are classified in Annex I, being the subject to special conservation measures concerning their habitat, in order to ensure their survival and reproduction in their area of distribution. Depending on their level of spreading, on their geographical distribution and the overall reproductive rate, species listed in Annex II of this Directive can be hunted under national law. Member States watch that hunting of these species to not compromise the efforts conservation undertaken in their area of distribution. The species listed in Annex II part 2 can be hunted only in the Member States because they are mentioned, in Chişinău these species are: *Cygnus olor*, *Gallinula chloropus*, *Larus cachinans*, *Streptopelia turtur*, *Streptopelia decaocto*, *Alauda arvensis*, *Sturnus vulgaris*, *Bombycilla garrulus*, *Garrulus glandarius*, *Pica pica*, *Corvus monedula*, *Corvus frugilegus*, *Turdus iliacus*, *Turdus merula*, *Turdus philomelos*, *Turdus viscivorus*, *Turdus*

pilaris. In annex III/1 și III/2 are included the following species: *Anas platyrhynchos*, *Aythya ferina*, *Perdix perdix*, *Fulica atra*, *Columba palums*.

Berne Convention regarding the conservation of wildlife and natural habitats in Europe adopted in Bern on September 19th, 1979. It came into force on June 1st, 1982. Moldova joined the Berne Convention in 1993 by (Decision of the Moldovan Parliament Nr. 1546–XII from 32.06.93). This convention aims to ensure the conservation of wild fauna and flora and their natural habitats; it pays special attention to endangered migratory species and the vulnerable ones. Annex II includes strictly protected fauna species, while annex III presents protected fauna species. 74 species of birds from Chisinau are to be found in Annex II and 27 species in annex III.

Bonn Convention Conservation of Migratory Species of Wild Animals, 1979. Annex II of the Convention classifies species having an unfavorable conservation status. 13 from Chisinau city are presented in this annex.

Law 1538/1998 regarding the funds of the natural areas protected by state. This law establishes legal foundations of the creation and operation of natural areas protected by state, principles, mechanisms and way of conservation. Annex III of the law lists rare flora and fauna species, establishing at the same time the rarity of the species category. 18 species noticed in green areas from Chișinău city are included in this annex.

Out of 110 species of birds identified in Chișinău, 33 are included in Birds Directive, 101 species in Berne Convention and 13 species in Bonn Convention; law 1538/1998 refers to 18 species of avifauna identified in Chișinău (table 1).

Based on the results presented in table 1 which reflects the high degree of protection of bird species from city's ornithofauna, but the real situation is not of the most favorable, because of non respect towards legislation, as well as the absence of tougher measures from the coercive force of the state. These inevitably leads to diminishing diversity and density of bird species both anthropogenic ecosystems and the natural one.

Given the location of bird life that compose urban avifauna, the protective measures that can be taken on their behalf are few, and often inapplicable. Because most species are insectivorous, it would be beneficial for birds to keep old trees, which is a source of food for species like: middle, woodpeckers, tits, biting etc. To the same end, would justify the reduction or elimination of insecticide treatments which is performed in cities during summertime. Practical means to protect urban avifauna refers to installation of artificial nests and bird feeders in green areas and awareness among population about the presence of birds in the city, aiming to avoid the demolition of the nests placed in areas frequented by people.

Conclusions

– Out of 110 species of birds identified in Chișinău, 33 are included in Birds Directive, 101 of species in Berne Convention and 13 species in Bonn Convention; law 1538/1998 refers to 18 species from avifauna identified in Chișinău.

– After investigations ended it was found that most species of birds from Chișinău ,s ornithofauna are insectivorous species, they serve as a regulator factor of insect pests. But it is necessary to preserve old trees, which is a source of food for species like: middle, woodpeckers, tits, biting etc.

– The national legislation, as well as international conventions that Republic of Moldova joined, on the issue of protection of bird species is most often not applicable, the latter lead to decreased diversity and abundance of bird species across the territory of the country

Table 1: The list of bird species identified in Chişinău city and their conservation status

Nr. ctr.	Species	List SPEC	Birds Directive	Law 1538/1998	Berne Convention	Bonn Convention
1	<i>Gavia stellata</i>	3	I	IV	II	II
2	<i>Podiceps cristatus</i>	Non SPEC			III	
3	<i>Ardea cinerea</i>	Non SPEC			III	II
4	<i>Nycticorax nycticorax</i>	3			II	
5	<i>Ciconia ciconia</i>	2	I	VIII	II	II
6	<i>Ixobrychus minutus</i>	3			III	II
7	<i>Cygnus olor</i>	Non SPEC ^E	II/2	IV	III	II
8	<i>Anas platyrhynchos</i>	Non SPEC	III/1		III	II
9	<i>Aythya ferina</i>	2	III/2		III	II
10	<i>Accipiter nisus</i>	Non SPEC		V	II	II
11	<i>Accipiter gentilis</i>	Non SPEC		V	II	II
12	<i>Aquila pomarina</i>	2	I		II	
13	<i>Buteo buteo</i>	Non SPEC		VIII	II	II
14	<i>Falco subbuteo</i>	Non SPEC		VII	II	II
15	<i>Perdix perdix</i>	3	III/2		III	
16	<i>Phasianus colchicus</i>	Non SPEC	III/1	VIII	III	
17	<i>Crex crex</i>	1	I	VII	II	II
18	<i>Gallinula chloropus</i>	Non SPEC	II/2		III	
19	<i>Fulica atra</i>	Non SPEC	III/2		III	
20	<i>Larus ridibundus</i>	Non SPEC ^E	II		III	
21	<i>Larus cachinans</i>	Non SPEC ^E	II/2			
22	<i>Columba livia domestica</i>	-			III	
23	<i>Columba palumbus</i>	Non SPEC ^E	III/1	VIII		
24	<i>Streptopelia turtur</i>	3	II/2		III	
25	<i>Streptopelia decaocto</i>	Non SPEC	II/2		III	
26	<i>Cuculus canorus</i>	Non SPEC			III	
27	<i>Asio otus</i>	Non SPEC		III	II	
28	<i>Athene noctua</i>	3		VIII	II	
29	<i>Srix aluco</i>	Non SPEC		VIII	II	
30	<i>Otus scops</i>	2			II	
31	<i>Tyto alba</i>			III	III	
32	<i>Apus apus</i>	Non SPEC			III	
33	<i>Alcedo atthis</i>	3	I	V	II	
34	<i>Merops apiaster</i>	3			II	
35	<i>Upupa epops</i>	3		VIII	II	
36	<i>Picus canus</i>	3	I		II	
37	<i>Dendrocopos syriacus</i>	Non SPEC ^E			II	
38	<i>Dendrocopos major</i>	Non SPEC			II	
39	<i>Dendrocopos medius</i>	Non SPEC ^E	I		II	
40	<i>Dendrocopos minor</i>	Non SPEC			II	
41	<i>Jynx torquilla</i>	3			II	
42	<i>Galerida cristata</i>	3			III	
43	<i>Alauda arvensis</i>	3	II/2		III	
44	<i>Hirundo rustica</i>	3			II	
45	<i>Delichon urbica</i>	3			II	
46	<i>Anthus trivialis</i>	Non SPEC			II	
47	<i>Anthus pratensis</i>	Non SPEC ^E			II	
48	<i>Anthus campestris</i>	3	I		II	
49	<i>Motacilla alba</i>	Non SPEC			II	

Nr. ctr.	Species	List SPEC	Birds Directive	Law 1538/1998	Berne Convention	Bonn Convention
50	<i>Motacilla flava</i>	Non SPEC			II	
51	<i>Lanius collurio</i>	3	I		II	
52	<i>Oriolus oriolus</i>	Non SPEC			II	
53	<i>Sturnus vulgaris</i>	3	II/2			
54	<i>Bombycilla garrulus</i>	Non SPEC			II	
55	<i>Garrulus glandarius</i>	Non SPEC	II/2		II	
56	<i>Pica pica</i>	Non SPEC	II/2			
57	<i>Corvus monedula</i>	Non SPEC ^E	II/2			
58	<i>Corvus frugilegus</i>	Non SPEC	II/2			
59	<i>Corvus corone cornix</i>	Non SPEC				
60	<i>Corvus corax</i>	Non SPEC		VII	III	
61	<i>Troglodytes troglodytes</i>	Non SPEC			II	
62	<i>Acrocephalus arundinaceus</i>	Non SPEC			II	
63	<i>Acrocephalus scirpaceus</i>	Non SPEC			II	
64	<i>Hippolais icterina</i>	Non SPEC ^E			II	
65	<i>Sylvia atricapilla</i>	Non SPEC ^E			II	
66	<i>Sylvia curruca</i>	Non SPEC			II	
67	<i>Sylvia borin</i>	Non SPEC ^E			II	
68	<i>Sylvia communis</i>	Non SPEC ^E			II	
69	<i>Phylloscopus collybita</i>	Non SPEC			II	
70	<i>Phylloscopus sibilatrix</i>	Non SPEC			II	
71	<i>Phylloscopus trochilus</i>	Non SPEC			II	
72	<i>Regulus regulus</i>	Non SPEC ^E			II	
73	<i>Hippolais icterina</i>	Non SPEC ^E			II	
74	<i>Muscicapa striata</i>	3			II	II
75	<i>Ficedula hypoleuca</i>	Non SPEC ^E			II	
76	<i>Ficedula albicollis</i>	Non SPEC ^E			II	
77	<i>Ficedula parva</i>	Non SPEC	I		II	
78	<i>Saxicola torquata</i>	Non SPEC			II	
79	<i>Phoenicurus phoenicurus</i>	2			II	
80	<i>Phoenicurus ochruros</i>	Non SPEC			II	
81	<i>Luscinia luscinia</i>	Non SPEC ^E			II	
82	<i>Erithacus rubecula</i>	Non SPEC			II	
83	<i>Turdus iliacus</i>	Non SPEC ^E	II/2		II	
84	<i>Turdus merula</i>	Non SPEC ^E	II/2		II	
85	<i>Turdus philomelos</i>	Non SPEC ^E	II/2		II	
86	<i>Turdus viscivorus</i>	Non SPEC ^E	II/2		II	
87	<i>Turdus pilaris</i>	Non SPEC ^E	II/2		II	
88	<i>Parus major</i>	Non SPEC			II	
89	<i>Parus caeruleus</i>	Non SPEC			II	
90	<i>Parus palustris</i>	3			II	
91	<i>Aegialus caudatus</i>	Non SPEC			II	
92	<i>Remiz pendulinus</i>	Non SPEC		VIII	III	
93	<i>Sitta europaea</i>	Non SPEC			II	
94	<i>Certhia familiaris</i>	Non SPEC			II	
95	<i>Passer domesticus</i>	3				
96	<i>Passer montanus</i>	3			III	
97	<i>Fringilla coelebs</i>	Non SPEC ^E			III	
98	<i>Fringilla montifringilla</i>	Non SPEC ^E			II	
99	<i>Pyrrhula pyrrhula</i>	Non SPEC			III	

Nr. ctr.	Species	List SPEC	Birds Directive	Law 1538/1998	Berne Convention	Bonn Convention
100	<i>Coccothraustes coccothraustes</i>	Non SPEC			II	
101	<i>Serinus serinus</i>	Non SPEC ^E			II	
102	<i>Carduelis chloris</i>	Non SPEC ^E			II	
103	<i>Carduelis spinus</i>	Non SPEC ^E			II	
104	<i>Carduelis carduelis</i>	Non SPEC ^E			II	
105	<i>Carduelis canabina</i>	2			II	
106	<i>Carduelis flammea</i>	Non SPEC			II	
107	<i>Loxia curvirostra</i>	Non SPEC				
108	<i>Miliaria calandra</i>	2			III	
109	<i>Emberiza citrinella</i>	Non SPEC ^E			III	
110	<i>Emberiza hortulana</i>	2			III	

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**SITUAȚIA CONSERVĂRII ȘI PROTEJĂRII SPECIILOR DE
PĂSĂRI IDENTIFICATE ÎN MUNICIPIUL CHIȘINĂU
(Rezumat)**

Cercetările au fost efectuate pe parcursul a cinci ani consecutiv în toate perioadele fenologice. Pe teritoriul municipiului Chişinău au fost identificate 110 specii de păsări, dintre care 33 sunt cuprinse în Directiva Păsări, 101 în Convenția de la Berna și 13 specii în Convenția de la Bonn. Legea 1538/1998 face referiri la 18 specii din avifauna identificată în municipiul Chişinău. Cele mai numeroase specii de păsări sunt insectivore și aparțin clasei paseriformelor; acestea servesc ca factor reglator al insectelor dăunătoare. Legislația națională, cât și acordurile internaționale la care Republica Moldova a aderat, privind problema protecției speciilor de păsări, este de cele mai dese ori neaplicabilă. Aceasta conduce la scăderea diversității și densității speciilor de păsări pe întreg teritoriul țării.

PALEONTOLOGY

THE BADENIAN MARINE FAUNA FROM NEAGONEA VALLEY (MEHEDINȚI COUNTY)

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Abstract: The paper presents the results of research on the marine fauna from the Badenian deposits located in the Neagonea Valley (southwestern Romania, Mehedinți District). From taxonomical point of view, the Badenian fauna assemblage includes mainly molluscs and corals. The fauna of Neagonea hydrographic basin and adjacent areas has affinities with the Badenian faunas from Bahna and Toplița, but lesser to the one in eastern Oltenia (Jiu and Olteț area) or one from Buituri (Hunedoara District). Three species are new for this area: *Corbula carinata*, *Pecten revolutus* and *Laevicardium herculeus*.

Keywords: molluscs, corals, Badenian, Mehedinți, Romania

Introduction

This study is focused on data issued from the research on marine fauna from the Badenian deposits located in the Neagonea Valley. This valley is situated 12 km northeast from Drobeta Turnu Severin, Mehedinți District, being part of the Mehedinți Plateau Geopark. From taxonomical point of view the marine macrofauna is rich and varied, dominated by molluscs (gastropods and bivalves) and corals.

Previous researches

Ștefănescu (1897) described in the Badenian marls of Ogașul cu Pârâu at Ilovăț, 24 species of gastropods and bivalves.

Marinescu et al. (1962) collected and studied the Badenian fauna of the Pârlagele area up to Coșuștea, including the hydrographic basin of Neagonea Valley and reported a list of 42 species of bivalves and 97 species of gastropods. In his monography “*Neogene stratigraphy of the Western Dacic Basin*” Marinescu (1978) describes the illustrative sections of the western Dacic Basin, including logs at the Sarmatian/Badenian boundary, which can be observed on the left tributaries of the Neagonea Valley.

Far later, 10 mollusc species originating from deposits cropping out on the left slope of the Neagonea Valley were identified by Diaconu & Meilescu (2011).

Diaconu & Meilescu (2012) proposed a track for people interested on geology, on this valley, the first of its kind in Mehedinți District. This track would encourage the scientific tourism, as an initiative to promote and support the research targeted towards the preservation of the natural heritage of the Mehedinți Plateau Geopark area.

Geological setting

From geological point of view, the studied area represents the westernmost side of the Dacian Basin and involves among other various lithologies, marl tuffite clay with numerous foraminifers, equivalent “*marls with globigerinae*” from Muntenia (Marinescu, 1978). These Badenian deposits form a continuous band around Godeanu, on Topolniței Valley to south, at Bala on Râienilor Valley. In this area, at Bâlvănești, near the contact with the metamorphic rocks the Badenian is cropping out. It concerns clays and fossil-bearing sandy clays.

Within the studied area, the Badenian sedimentary succession begins with the level of marls bearing globigerinae and continues with marls, sands, sometimes interbedded with gravel -which contains the richest fauna- and tuffite or tuffitic clays.

Locally, in the Bâlvănești sector, above them there is very fossil-bearing gravel, sand and marl clay. They also include a layer of volcanic tuffite. To the north, sands and marl clays reach big thickness, replacing the gravel.

The Badenian deposits sequence exposed on the left bank of Neagonea Valley contains (fig.1): gravel with boulder (2 m), fossiliferous gravel (1.5 m), clay with tuffite lens (1m), coarse gravel mixed with boulders (4 m), sandy layers and blocks (5 m).

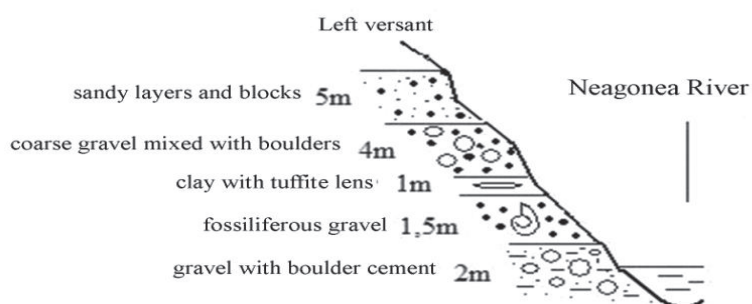


Fig. 1: Lithologic section of the Badenian deposits of Neagonea Valley

Material and methods

The material presented here was collected for improving the paleontological collection of the Iron Gates Region Museum in Turnu Severin. The findings are important because they originate from the sands and clay sands where they were preserved. The species were assigned based on measurements and morphology, than compared with the specimens described and figured in paleontological references.

Systematic part

Class ANTHOZOA

Order *Hexacoralia*

Family Faviidae

Genus *Favia*, Oken, 1815

Favia magnifica Reuss, 1871 (Pl.I, Figs. 2,3)

1909 *Favia magnifica*, Macovei, p.130–131, pl. VII, fig. 4

1999 *Favia magnifica*, Enache, Popescu, Calopăreanu, p. 36, pl. I, fig. 1, 2

Description. Irregular colonies, with round calices sometimes garbled. Calices stuck between them, rises about 1 mm above the surface of the colony. Inside the calices is observed at least 12 main blades that meet in the center on columelle.

Order *Hexacoralia*

Genus *Solenastrea*, A. E. Reuss, 1864

***Solenastrea manipulata* Reuss, 1871 (Pl. I , Fig. 3)**

1909 *Solenastrea manipulata*, Macovei, p. 135, pl. IX, fig.3

1972 *Solenastrea manipulata*, Macarovici, Turculeț, pag.181, pl. LVI, fig.10

1973 *Solenastrea manipulata*, Clichici, pl. XIX, fig.10.

Description. Colonies of circular calices with a diameter of lesser than about 2 mm, which rises above the level of the intercalice. The two fragments are identical to those listed by Clichici (1973). Large colony, well individualized polipyers with 3 mm diameter, separated by spaces 1 mm wide. Septa are extended outwards.

Remarks. The species *Solenastrea manipulata* Reuss was reported in the Badenian limestone from Curchia in Bahna basin and in the eastern side of the **Șimleu** basin.

Genus *Heliastrea*,

***Heliastrea conoidea* Reuss, 1871 (Pl. I, Figs. 4–7)**

1909 *Solenastrea conoidea* Macovei, p. 132–123, pl.VII, fig.5

1972 *Solenastrea conoides* Macarovici, Turculeț, p. 181, pl. LVI, fig. 5

1973 *Soleastrea manipulata* Clichici, pl. XIX, fig.10.

Description. Conic colony, elongated, with circular calices, joined. Their edge rises well above the intercalicial space. The diameter of polipyers is 2–3 mm, separated by 1 mm.

Remarks. Marinescu et al. (1962) reported this species at Pârlage.

***Heliastrea reussiana* Edwards & Heime, 1953 (Pl. II , Figs. 1,2)**

1909 *Heliastrea reussiana*, Macovei, pl.VII, fig.5 a,b

1972 *Heliastrea reussiana*, Macarovici, Turculeț, pag.181, pl. LVI, fig. 5

1973 *Heliastrea reussiana*, Clichici, pl. XIX, fig. 9

Description. Irregular colony with polipyers well individualized, with circular diameter of 2.5–3 mm, separated spaces with irregular widths of 1–2 mm. Around the calices are 24 prominent septa.

Remarks. This species differs from *Solenastrea manipulata* by irregular spaces between polipyers and the lack of columelar axis.

Class BIVALVIA

Order *Ostreoida*

Family *Ostreidae* Wilkes, 1810

Genus *Ostrea* Linné, 1758

Subgenus *Ostrea* Linné, 1758

***Ostrea (Ostrea) digitalina* Dubois, 1831 (Pl. II, Figs. 3, 4)**

1955 *Ostrea (Ostrea) digitalina*, Moisescu, pag. 108–109, pl. VIII, fig.24

1972 *Ostrea digitalina*, Macarovici, Turculeț, pag. 185–186, pl. VI, fig. 16a, pl. VII, fig. 2b

Description. Upper valve is quite thin almost flat, smooth, and the muscular imprint pear-shaped. Bottom valve is smooth. On the cardinal plateau sees a ligament fosse deep enough. The muscular imprint is big with an oval outline, in the back side.

Family Carditidae

Genus *Cardita* Bruguiere, 1792

***Cardita jouanneti* Basterot, 1852 (Pl. II, Fig. 5)**

1955 *Cardita (Megacardita) jouanneti*, Moisescu, pag. 86–87, pl. IV, fig.1,3

1972 *Cardita (Megacardita) jouanneti*, Macarovici, Turculeț, pag.183, pl.LVI, fig.176

1973 *Cardita jouanneti*, Clichici, pl. XII, fig.5.

Description. Valves are big and thick. The external surface of the valve is covered with broad radial ribs. The inter-rib narrower are ranges. The ribs and inter-rib widen from umbonal part up to the lower edge of the valve. These are covered by well highlighted growth striations.

Remarks. It is the only Badenian species of *Cardita* missing tubercles on the ribs, but exposes growth striations well marked.

Family *Pectinidae* Lamark

Genus *Pecten* Müller, 1776

***Pecten revolutus* Michelotti, 1897 (Pl. II, Fig. 6)**

1977 *Pecten revolutus*, Clichici, p. 126–127, pl. III, fig. 1–4

Description. The right valve is curved and the left valve almost flat. The left valve is ornamented with 11–12 radial ribs, smooth, well highlighted, separated by inter-rib area twice wider than the ribs. On the inner face shows wide ribs corresponding to inter-rib space on the external face.

Remarks. The left valve differs from that of the species *Pecten subbenedicuts*, by flatter ribs and narrower than the inter-rib spaces.

***Pecten cf. hornensis* Deperet & Roman, 1902 (Pl. II, Fig. 7)**

1960 *Pecten cf. hornensis*, Popa, p. 333–335, pl. I, fig.3, pl. II, fig. 9.

Description. Triangular-rounded shell with specific ears. The dorsal face exhibits ribs that widen to the lower edge, flattened, with edges at right angles. Inter-rib spaces are less wide (1/2 the width of the coast).

Remarks. Present in the Early Miocene.

Genus *Chlamys*

***Chlamys elegans* Andrzejowski, 1870 (Pl. III, Figs. 1–4)**

1968 *Chlamys elegans*, Iliescu, Hinculov, Hinculov, p. 87, pl. 8, fig. 2,3.

1977 *Chlamys elegans elegans*, Nicorici, p.137–138, pl. XXIV, fig.1,2,3, pl. XXV, fig.1, 2, pl. XXVII, fig.3,4,5

Description. Triangular-rounded shell with specific ears. The dorsal face shows ribs with sharp rounded ridges around the crochet. Then, these are divided into 3 ridges which widen towards the lower edge, flattened, with right angled edges. The inter-rib rear is covered by a secondary ornamentation represented by fine blades.

Remarks. The samples figured by Nicorici (1977) in pl. XXVII come from Ilovăț. Marinescu et al. (1962) reported this species at Pârlage.

***Pectunculus (Glycymeris) pilosus* Linné (Pl. III, Figs. 5–6)**

1968 *Pectunculus (Glycymeris) pilosus* Hinculov, pl. IV, fig.3.

1972 *Pectunculus (Glycymeris) pilosus* Macarovici, Turculeț, p. 184, pl. LVII, fig. 4.

Description. Valves thick, convex, with rounded contours, almost circular. Umbonal part high, opistogire, slightly inclined towards the cardinal edge. The outer surface shows radial flattened ribs, starting at umbonal part, trace the growth and rare concentric ribs, irregularly. Teething heterodont with 4–5 teeth disposed on each side of the cardinal plateau, the median being toothless.

Remarks. The illustrated specimen differs of *Pectunculus (Axinaea) deshaesi* (Mayer) by the smaller number of teeth, and by *Glycymeris cor*, because it has some asymmetry of the shell.

Familly Tellinidae

Genus Tellina Linné 1758

***Tellina donacina* Linné, 1758 (Pl. IV, Figs. 1–2)**

1955 *Tellina donacina*, Moisescu, p. 79, pl. II, fig. 3

1972 *Tellina donacina*, Macarovici, Turculeț, p. 182, pl. LVI, fig. 15

Description. Valves are oval-elongated, asymmetrical, thin and slightly convex. The umbonal part is opistogire, slightly elevated above the small cardinal shelf. The length is 13–20 mm.

Familly Corbulidae

Genus *Corbula* Bruguire, 1797

***Corbula carinata* Dujardin, 1837 (Pl. IV, Figs. 3–4)**

1955 *Corbula (Corbula) carinata*, Moisescu, p. 112–113, pl. 6, 8

Description. Valves asymmetric inequilaterally with elongated oval contour. The right valve is bigger than the left one. The backside edge joins with the bottom one an acute angle with rounded top. On the dorsal side, the surface is lined with coarse concentric ribs.

Familly Cardiidae

Genus *Laevicardium*, Swainson, 1840

***Laevicardium herculeus* Dollfus, Cotter et Gomez, 1904 (Pl. IV, Figs. 5–6)**

1955 *Laevicardium (Discors) herculeus*, Moisescu, p. 85–86, pl. III, fig. 1, 2

Description. It has a thick, asymmetric large shell, with oval-triangular shape, developed in height. The convexity decreases to edges. The external surface has multiple radial ribs (over 20), contoured toward the middle of the valve. From spot to spot presents concentric ribs. A previous muscular impression is visible. The rear one is less visible.

Remarks. This species is widespread in Miocene.

Class GASTEROPODA
Family Cerithidae
Genus *Cerithium* Bruguiere, 1789

***Cerithium europaeum* Mayer, 1878 (Pl. IV, Fig. 7)**

1909 *Cerithium europaeum*, Macovei, p. 157, pl. XI, fig. 13
2007 *Cerithium europaeum*, Vazza, Cecalupo, p. 182, Pl. 5 fig. i.

Description. Prominent conical shell. The shifts of mind partially are overlapping. The suture is impressed and allowed to see the granular cingulum. The aperture is narrow and smooth. The edge of columella is sightly callosous.

Family Conusidae
Genus *Conus* Linné, 1758

***Conus ponderosus* Brocchi, 1814 (Pl. IV, Fig. 9, 10)**

1955 *Conus (Lithoconus) ponderosus*, Moiescu, p. 164–165, pl. XIV, fig. 10, 11
1972 *Conus ponderosus*, Macarovici, Turculeț, p. 188, pl. LVIII, fig. 11

Description. The conical shells, with 8–9 shifts, the last variant form occupyes $\frac{3}{4}$ of the height of the shell. The surface of shell is smooth, without carving. The aperture is oval, slightly elongated. The height of shell is 18–30 mm.

Remarks. The species is present in Badenian deposits of Europe.

Family Turritellidae
Genus *Turritella* Lamarck, 1799

***Turritella* sp. (Pl. IV, Fig. 8)**

Description. A fragment of a very poorly preserved specimen that does not allows species' identification.

Paleoecological considerations

In the assemblage from Neagonea Valley are present also molluscs with primitive characters (e.g. *Cerithium*). A wide variety of molluscs of the genera *Pecten*, *Chlamys*, *Ostrea*, *Cardita*, *Turritella*, *Conus*, and corals indicate relatively warm seas.

In the sub-littoral realm of subtropical basins up to 70 m depth one can meet *Turritella* and *Cerithium* and temperatures above 21 °C. *Turritella* is a representative of Indo-Pacific marine species that prefer shallower waters (1–27 m).

In the assemblage of bivalves from Neagonea Valley one can noticet epi-faunal representatives. Most of them actually live in the coastal realm and have a maximum development up to 300 m in depth (*Pecten*, *Chlamys*). In the juvenile stage, *Chlamys* is living as fixed organism on bedrock, and in adulthood becomes free.

Among the carnivorous gastropods, *Conus* is a sifonostomate species, which lives only in seas with normal salinity in coastal-tropical zones (1 to 80 m depth), in rich oxygen water, in association with other molluscs, on the coral reefs (Tița, 2009).

Conclusions

In the outcrop from Neagonea Valley collected a very taxonomically diverse Badenian invertebrate fauna, including mainly molluscs and corals.

The fauna of Neagonea River hydrographic basin and adjacent areas has affinities with the Badenian fauna from Bahna and Toplița areas, but lesser to the one in eastern Oltenia (Jiu and Olteț) or one from Buituri. Among the collected and studied taxa, it mention three species that were not reported so far in this area: *Corbula carinata*, *Pecten revolutus* and *Laevicardium herculeus*.

The paleoecological conditions in the Neagonea River basin show the existence of a coastal marine environment with normal salinity waters, in subtropical climate.

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**FAUNA MARINĂ BADENIANĂ DE PE VALEA NEAGONEA
(JUDEȚUL MEHEDINȚI, ROMÂNIA)
(Rezumat)**

Acestă lucrare prezintă rezultatele cercetărilor privind fauna marină din depozitele badeniene de pe Valea Neagonea. Din punct de vedere taxonomic asociația faunistică badeniană cuprinde în principal moluște și corali.

Fauna din bazinul pârâului Neagonea și din zonele adiacente are afinități cu faunele badeniene de la Bahna și Toplița și mai puțin cu cele din estul Olteniei (dintre Jiu și Olteț) sau cu fauna de la Buituri. Dintre taxonii colectați și descriși, menționăm trei forme neseamnalate până în prezent în această zonă: *Corbula carinata*, *Pecten revolutus* și *Laevicardium herculeus*.



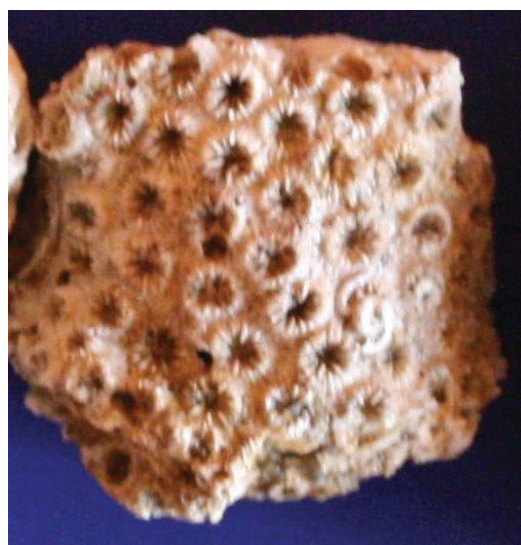
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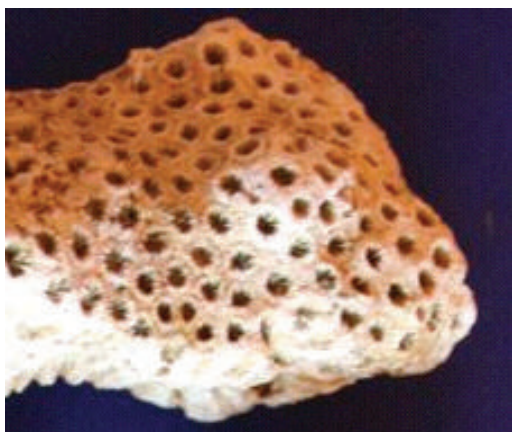


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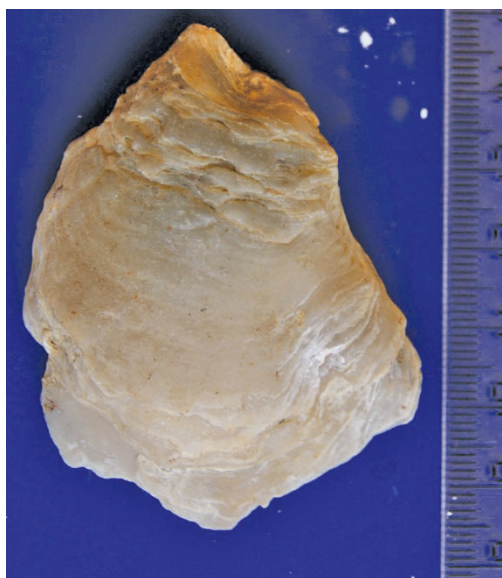
Plate I. 1, 2 – *Favia magnifica*; 3- *Solenastraea manipulata*; 4–7 *Heliastrea conoidea*



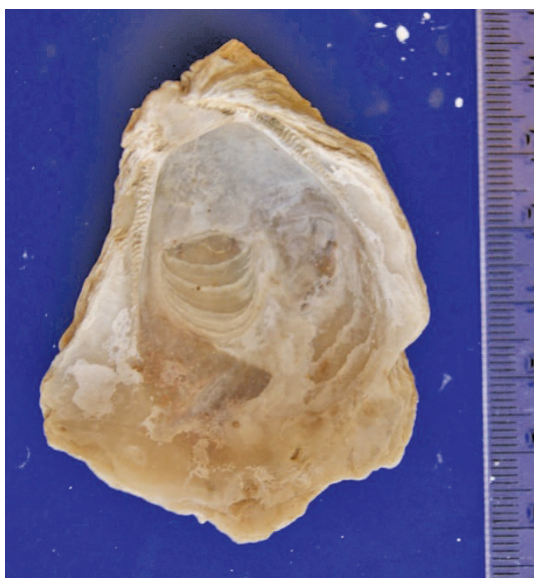
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Plate II. 1, 2 – *Heliastrea reussiana*; 3, 4 – *Ostrea (Ostrea) digitalina*; 5 – *Cardita jouanneti*; 6 – *Pecten revolutus*; 7 – *Pecten cf. hornensis*



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Plate III. 1–4 *Chlamys elegans*; 5–6 *Pectunculus (Glycymeris) pilosus*.



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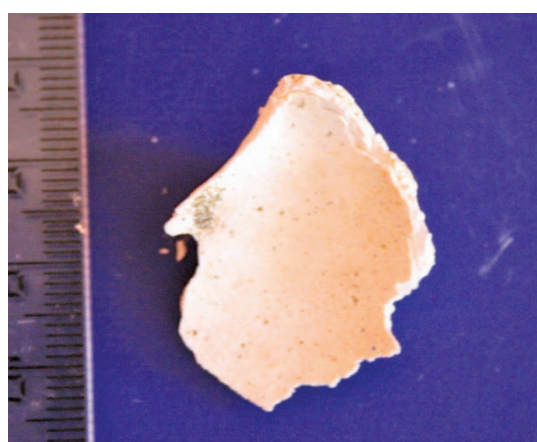
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Plate IV. 1–2 *Tellina donacina*; 3–4 *Corbula carinata*; 5–6 *Laevicardium herculeus*;
7 – *Cerithium europaeum*; 8 – *Turritella* sp.; 9–10 *Conus ponderosus*.

ISSN 1016-9652